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Energy Management

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Abstract

Industry is one of the largest consumers of energy in the EU economy and ever-increasing worldwide demand for energy will continue to push prices upward. Manage energy consumption and minimizing energy costs have long been a high priority. Many manufacturers have already done much to improve the energy efficiency of their plants by repairing or replacing old or inefficient equipment, and through maintenance, instrumentation, and automation programs.

However, achieving energy efficiency is only the first step in building and maintaining an effective energy management program that can pay dividends over time. A dynamic energy market in which energy prices can change several times a day makes managing energy costs more complex. An expected tax or cap and trade system for carbon emissions will further complicate matters.

Organizations need to have a broader perspective, and take a holistic approach to energy management that goes beyond discrete projects at the equipment and plant level. Those that actively manage energy inputs and emissions on a daily basis and leverage automation and information technologies to address energy consumption in a systematic and consistent manner will have a competitive advantage going forward.

Companies that can accurately measure, monitor, predict, and control their energy usage have many other opportunities to lower their energy consumption, wastes, and costs. Many energy management strategies, functions, and solutions are available today. Energy efficiency begins with energy-efficient process and equipment design. To manage ongoing operations effectively, organizations must address energy management from the enterprise level down to field devices and motor controls.

Resumo

É na indústria que se encontram alguns dos maiores consumidores de energia na economia da União Europeia, além disso a procura de energia por esse mundo fora continuará a fazer aumentar os preços deste recurso. Gerir consumos energéticos e minimizar custos são já uma prioridade para as companhias. Muitas, fizeram já muito para melhorar no campo da eficiência energética das suas fábricas, reparando ou substituindo equipamento ultrapassado, com operações de manutenção e sistemas automáticos.

Contudo, atingir uma eficiência energética é só o primeiro passo para uma continuidade que traga dividendos consideráveis a longo prazo. Um mercado energético dinâmico, onde os preços mudam constantemente, transforma a gestão dos custos energéticos mais complexa. O esperado surgimento de uma taxa para emissões de carbon tornará tudo ainda mais complexo. As organizações precisam ter uma perspectiva mais ampla e ter uma abordagem holística para a gestão de energia que vai além de projetos distintos ao nível do equipamento e da fábrica. Aqueles que gerem ativamente consumos energéticos e de emissões numa base diária, devem recorrer á automação e ás tecnologias de informação de forma a tratar o consumo de energia de uma forma sistemática e consistente, algo que trará vantagens a longo prazo.

Companhias que com precisão conseguem medir, monitorizar, prever e controlar o uso de energia interno, têm tudo para baixarem consumes, perdas e custos. Muitas estratégias, ferramentas e soluções de gestão de energia estão disponíveis nos dias de hoje. A eficiência energética, começa com processos energéticament eficientes e com o próprio design do equipamento. Para controlar operações em tempo real, as companhias precisam de sensibilizar todos os seus trabalhdores e analisar ao pormenor cada motor, por mais pequeno que seja.

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Abbreviations, Acronyms and Symbols

FEUP	Faculty of Engineering of the University of Porto
EMS	Energy Management System
PB	Particleboard
OSB	Oriented Strand Board
kW	Kilowatt
PVC	Polyvinyl chloride
SEC	Specific Energy Consumption
MFC	Melamine Faced
ISO	International Organization for Standardization
€	Euros
SA	Anonymous Society
SONAE	Sociadade Nacional de Estratificados
h	Hour
m^3	Cubic Meter
m^2	Square Meter
m	Linear Meter

Chapter 1

Introduction

1.1 - Description of the problem

On the next pages, you will read about wood industry, more precisely, about wood based panels manufacturing processes, the way that energy could be related to it, and what is possible to do, to turn this industry into a reference into energy efficient cases.

Wood is the only construction material that stores carbon. This is one of the reasons that turn this manufacture, into an environmental friendly industry. It is known that, wood is Earth's most renewable raw material and using it is vital in the fight against climate change. The more wood is used, the more trees are grown, the more carbon is stored, the more oxygen is released to the atmosphere, and the better our world will be.

In spite of all this universal truths, wood based panels industry, is very complex, it deals with mass volume production, and every single detail in the productive process could mean losses that rounds millions. So, there is always something to improve, and the optimal point is something that should be always chased.

SONAE Indústria, the company where all the publication was based in, gives special attention to sustainability, and the work developed last years, is being recognized several times. Projects related to energy efficiency, are having special attention, for the simple fact that energy represents about 15% of total industrial costs. In the past, energy was a virtual

resource that everyone used without any saving worries, the resource was in the lowest level of companies' interests. Nowadays, with new mentalities, new challenges and new tools, the panorama is changing, and the companies started to care about manage this resource and make it so efficient as much as they could.

Energy has a huge value in our lives. As we know, energy sector activities include extraction, conversion, transportation, energy consumption and disposal of energy wastes.
Energy needs, are a quantitative measure of total energy required for a product manufacture, including the energy relative to materials conversion, transporting, lighting, providing heat for the process, and all the subsequent phases that involves any manufacturing industry. MJ per Ton of product is normally the unit where these measures are based. We can use it to evaluate our energy efficiency levels (Barratt, 1996, p. 615).

Manage energy, is critical in terms of our economic prosperity and environmental priorities. Energy is a vital resource for the good functioning of our industrialized world, and it is essential to help in the development of under developed countries. Obviously that energy production and consumption, without sustainability concerns, will only cause damage, and some of those, very serious to our world.

Attending all those facts, it is possible to assure that, energy management is, for sure, one of the most important areas of our days, as humanity future depends so much on it.

Under these circumstances, people need to be aware of the traditional sources of energy, their availability, environmental effects and quality. Top management people, should pay attention to the strongest alternatives for energy, and understand their capacity to fulfill modern industrial requirements. In the past two hundred years, only primary sources of energy we used, like waterpower, coal or firewood. Nowadays managing energy is one of the greatest issues of our world.

Air, land and water, are being constantly stressed by humans, and the search to reach our interests is getting too dangerous to our planet sustainability. So, limits are needed, targets are needed, conscious minds are indispensable, it is definitely needed to make a decision, if people want to play around with their grandsons. Sustained development is the key to success.

Improve competitive position, maximize profits and minimize costs, are the targets of energy management.

To assure that all major activities in a factory are examined to be optimized, a deep overview from the totality of the processes that involve this industry is necessary, and afterwards it will be possible to manage energy properly.
To manage properly, energy audits are required, where all energy related processes are precisely detailed.

Industrial energy audits have exploded as the demand to lower expensive energy costs and move towards a sustainable future turned energy audits indispensable. Their importance is magnified since energy spending is a major expense to industrial companies.

There are some common concepts to a home or residence energy audit, but, industrial energy audits require another methodology. For industrial applications, weatherproofing and insulating, which are the focus of home energy audits, often are minor concerns. In industrial energy audits, it is the production equipment, the HVAC and lighting that use the most energy.

Principles of Energy Management:

- Procure all the energy needed at the lowest possible price (Example: buy from original sources, review the purchase terms)

- Manage energy use at the highest energy efficiency (Example: improving energy use efficiency at every stage of energy transport, distribution and use)

- Reusing and recycling energy by cascading (Example: waste heat recovery)

- Use the most appropriate technology (select low investment technology to meet the present requirement and environment condition)

- Reduce the avoidable losses. (Make use of wastes generated within the plant as sources of energy and reducing the component of purchased fuels and bills)

Managing energy is something that is possible in every organization, from big corporations, like SONAE Indústria, to small businesses. However, there are some strategic points, which should be followed, in order to obtain successful results.

Energy management strategy includes the following guidelines:

1. Make commitment;
2. Assess performance;
3. Set goals;
4. Create action plan;
5. Implement action plan;
6. Evaluate progress;
7. Recognize achievements.

All these processes require a team directed to energy management that should include people from each department of the factory. Senior management to provide leadership, define company's energy policy, where are included, targets, new projects definition and energy team creation. At least an energy management team, should include, a financial department, to make investments follow up, a production team, to ensure that energy is properly used and finally, engineering department to operate and maintain the plant efficient.

One of the biggest responsibilities of this energy management team is to report results and go ahead to management on a daily/weekly basis. There should be a plan, with constant follow-up reports among factories plants, normally where the different energy teams could discuss energy saving opportunities, projects that are already implemented and respective results.

Energy management process is endless and goes deep in the life of an organization. Nobody can say that energy management process has been completed. It should be side by side with all company's routines.

1.2 - Purpose of the Thesis

Production of wood-based panels impacts the environment through the sourcing of raw materials and the effects of production processes such as air emissions, wastewater discharges and waste disposal. SONAE Indústria primary raw material is wood and as a big consumer of this recyclable, renewable and natural material, there is a commitment, which is part of company's business model and that protects the environment. Considering Environmental Awareness, a commitment to eco-efficiency and sustainable sourcing of raw materials was defined as main objective.

New projects are appearing and it is pretended to extend the energy efficiency plan to the entire universe from the company. Each plant will prepare an Energy Efficiency Plan to be integrated into the Industrial Master Plan that will include all actions considered necessary to follow the first version of the Standards. This Energy Management System is integrated on the industrial master plan, and it is supposed to be common to all different plants from SONAE Indústria in the future.

The framework of the Energy Efficiency Standards includes management measures such as more efficient use of existing equipment through improved operation, maintenance or retrofit of equipment. However, new technologies and investments such as the acquisition of more efficient new equipment and introduction of new processes and systems should also be considered.

Energy Management System is one of SONAE Indústria big projects, and this publication, will follow the implementation of the pilot, in Nettgau, place where SONAE owns their biggest plant in Europe.

So, the main purpose of the thesis is to implement a common and global EMS platform for online monitoring of energy performance, to be used as basis to eliminate waste, reduce and control current level of energy use and improve the existing operation procedures.

1.3 - Objective of the Thesis

Energy Management is a very complex theme, with a huge number of variables, and involving every process, every person and every kind of machine or any other equipment inside a factory. So, in order to define the main thesis objectives, according to the project, I have selected the following:

- Create daily energy awareness at all levels of operation
- Involve main energy users for a more efficient way of using it (with targets)
- Improve energy efficiency on a daily base
- Improve energy management behaviors supporting ISO 50001 certification

1.4 - Methodology of study

The thesis research methodology was a result of a concrete case study, which is the SONAE Indústria energy efficiency policy and mainly this project, complemented with a deep exploratory research among books, articles, websites, reports and publications that allowed me to better understand the theme and made me prepared to write this thesis and develop the project.

Energy Management it's a thematic that exploded last years, and as consequence the information is vast, and it was needed to organize everything properly, in order to make the study concrete and efficient.

Firstly, I developed a theoretical frame, based on the exploratory research that I referred on the first paragraph of this sub-chapter.

After that, getting on project scope, follow all steps since the beginning, create a detailed work plan, relate it with theoretical study, and try to build a document where the readers can understand what means Energy Management, and at the same time, follow a concrete project since the beginning, and percept, every step that is required to achieve success.

1.5 - Limitation of the Thesis

Energy Management is a vast area, and for sure that are concepts that won't be referred on this document, although all the main concepts are present and detailed on the following chapters.

The main limitation was to get updated data to get precise conclusions from this system implementation and define a variety of reports to be delivered regularly. The fact is that we have started from zero, when my work started, the company was discussing with the external provider, responsible for the implementation of the new EMS, terms and condition of the contract. In this document, all those phases will be detailed, that is very good to understand how a company does start and complete a project like this, but unfortunately, there was not too much time to analyze and define new efficiency measures resulting from our new monitoring system.

However, the implementation was successfully completed and some of the system's collected data, and types of reporting will be present on this document.

1.6 - Structure of Chapters

This document is presented in six chapters and respective bibliography at the end.
In the first chapter is focused on the project theme, with a description from the problem, and respective definitions, it could be found also the purpose, objective, methodology and

limitation of the thesis, that allows the reader to understand the meanings of the document's existence.

In chapter two, it is presented the company that promoted this project, explaining the core business, the international representation from the company, and a chronologic overview since the beginning of Sonae Indústria. There is a last reference to the factory that was chosen to implement this project, presenting the plant, the materials that are produced on that same plant and the respective description of productive processes.

Energy Management theory appears on chapter three. On this chapter are referred and detailed, all different phases that compose the adoption of an energy management policy inside a company.

In chapter four, there is a focused analysis of the management system itself, understand what is it, the importance of monitor data and target new objectives, and finally, the relation between a EMS and the achieve of the new certification ISO 50001:2009, that is one of the reasons that encourage Sonae Indústria to go ahead with projects like this.

The project itself, including the pretensions, the role since the beginning, considering negotiation, installation, configuration and execution phases, is detailed in a summarized form on chapter five.

In chapter six, there are some recommendations that can be useful in the future, and there it is the conclusion also.

Chapter 2

SONAE Indústria P.C.D.M., S.A.

2.1 Company Presentation

SONAE Indústria is a manufacturer of engineered wood products, founded and headquartered in Maia, Portugal. Present in twelve countries within three continents, Sonae Indústria has a wide range of products, from simple board to complete construction systems, a large range of wood-based products and materials for furniture, construction and decoration.

The current SONAE Indústria core business was the original and sole business of Sociedade Nacional de Estratificados (SONAE). SONAE was founded in 1959 in Maia. Its first activity was the production of high pressure decorative laminates. SONAE Indústria is a spin-off from Sonae SGPS, today a conglomerate with activity in several businesses (retail, supermarkets, real estate, etc.), excluding engineered wood. The separation of SONAE Indústria was in 2005. Today it is one of the world leaders in the wood-based products sector. This position was achieved after the takeover of the German company Glunz AG, in 1998, followed by an organic growth. This helped to consolidate the company globalization process. The demerger-merger and merger operation of SONAE – SGPS, S.A. began on September 2005. This operation consisted of a split of part of the shareholding held by SONAE – SGPS, S.A. in SONAE Indústria – SGPS, S.A. and its integration in SONAE 3P – Panels, Pulp and Paper, SGPS, S.A.. This last company integrated the full share capital of SI through a simultaneous merger operation. With this operation and as from December, 20th 2005 SI is extinguished and the company SONAE 3P – Panels, Pulp and Paper, SGPS, SA is renamed SONAE Indústria, SGPS, SA.

2.2 International Representation

Founded and based in Maia, Portugal, SONAE Indústria is in twelve countries within three continents, offering a wide range of products, from simple board to complete construction systems, a large range of wood-based products and materials for furniture, construction and decoration.

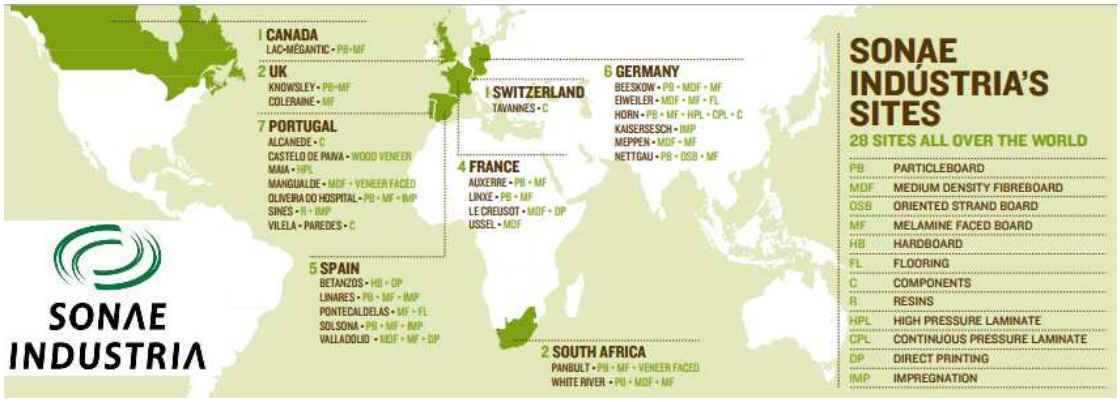


Figure 2.1 – SONAE Indústria's Universe

- Canada - Sonae Indústria is present in Canada by its subsidiary Tafisa Canada[2] in Lac-Mégantic, Quebec, since 1995 as an investment of Tableros de Fibras, S.A., later on acquired by the Sonae Indústria Group[3]. Since 2003, it became the first member of the Composite Panel Association (CPA) and producer of particleboard and thermofused melamine panels whose environmental management system met the requirements of ISO 14001[4]. On 2012, Tafisa Canada invested 10 million CAD on its facilities in order to recycle around 2 million trees per year[5]. Tafisa Canada has received a third party certification for CARB Phase 2 compliance, as well as the FSC, LEED, EPP, SCS, ISO 14001 and ISO 9001 certifications.

- France - Sonae Indústria is present in France since 1998, when adquired Isoroy SAS.[6] Nowadays, it operates in 4 plants: Auxerre, Le Creusot and Ussel,_Cantal by its subsidiary Isoroy and Linxe by its subsidiary Darbo.

- Germany - With 6 plants around the country (Beeskow, Eiweiler, Horn, Kaisersesch, Meppen and Nettgau, it is present via its subsidiary Glunz AG. Glunz AG was founded in 1932[7] and in 1992, acquired Isoroy SAS, which still operates in France, being acquired by Sonae Indústria Group five years later[8].

- Portugal - Sonae Indústria headquarters is located in Maia, as well as the oldest active factory from the Group [9]. They own as well other six plants around the country in Alcanede, Castelo de Paiva, Mangualde, Oliveira do Hospital, Sines and Vilela

- South Africa - South Africa operations are based in two locations: Panbult and White River. During the latter part of 1998, Sonae Indústria invested in a R350 million plant in Panbult Mpumalanga. Two years later acquired Sappi Novobord, including White River at their plant list.[10].

- Spain - Sonae Indústria has presence in Spain via its subsidiaries Tafisa and Tafibra, with plants in Betanzos, Linares, Pontecaldelas, Solsona and Valladolid.[11]

- United Kingdom - Spanboard Products Ltd at Coleraine in Northern Ireland began production in 1959 and was acquired by Sonae Industria, Portugal's largest privately owned industrial group in 1989. The company was extensively refurbished in the early 1990s when a new state of the art panel line for edged panels was installed. Investment was also made in a computerized panel saw to provide a cut to size service for melamine faced panels and gives greater flexibility for customer service. The factory produces wood particle board to meet the criteria of both, BS EN 312, (physical requirements for Particleboard) and also the site Quality Management System, which operates to ISO 9001. The Knowsley, Merseyside site was designed with environmental management in mind, with the latest technologies incorporated to satisfy the environmental requirements of BAT (best available technique). The main emission point on the site is a WESP (wet electrostatic precipitator) which is served by an 85m stack and all other emission points are served by the latest cyclone and bag filter equipment. The site operates under local Authority, Knowsley Metropolitan Borough Council and is regularly monitored to ensure the site achieves all its emission limits. The Knowsley plant which opened in July 2000 was specifically designed to use recycled wood fiber. Currently around 98% of material used at Knowsley is recycled. The Knowsley site operates an Environmental Management System (EMS) to the ISO

14001 standard (Certification/Quality). The EMS covers all aspects of raw material supply and production. The Knowsley site also adheres to a Sonae Industria Group Environmental Policy.

- Former Operations - Sonae Indústria had an operation in Brazil, which has been sold to Celulosa_Arauco_y_Constitución in 2009[12], in a deal worth US$227m.

2.3 Chronological Overview

1959	Sonae was founded, as an industrial company to produce decorative panels based on a core of grape stalks as a basic raw material. Unexpected technological problems delayed its start-up and led to a shift in production to high-pressure decorative laminates.
1963	LAMINITE was launched on the market and is still known today worldwide as Sonae's decorative laminate brand.
1971	Sonae entered the wood-based panels business, through the acquisition of a 50% stake in a particleboard manufacturing company - NOVOPAN - and started the production of melamine and veneer faced chipboard. At the same time it began the process of vertical integration, through the production of components for furniture and chemicals.
1989	Sonae Indústria was already the leader in wood-based panels in Portugal and started the process of internationalization and expansion. This was achieved through the acquisition of a particleboard company in the UK.
1993	Acquisition of Tafisa (which brought access to Canada, with what is today one of the the biggest plants in the world) and also to the Greenfield plants in Brazil (for particleboard and MDF) and in South Africa (particleboard).
1998	At the end of 1998 acquisition of GLUNZ, thereby also acquiring an important position in France (through Isoroy).
2000	Takeover of Sappi Novobord in South Africa. At the same time Sonae Indústria began an ambitious program of diversification of the product range and modernization of its technical assets, with important investments in the production of particleboard (new lines in Portugal and in France, a huge capacity increase in Canada and greenfield sites in Spain, UK and Germany), MDF

	(new lines in France and Brazil) and OSB (in Germany, at the greenfield site of Nettgau).
2006	Additional melamine facing capacity has also been installed in Portugal, Spain, France, UK, Germany, Brazil and Canada together with new wood veneering facilities at the Mangualde site in Portugal. Flooring plays an increasingly important role in Sonae Indústria's strategy with on-going investments in France, Spain, Germany and Brazil. Acquisition of Hornitex assets in Germany and the Darbo particleboard plant in France.
2007	Acquisition of Tafisa minority shareholdings and delisting from Spanish market. New particleboard production line in South Africa. New melamine production line in Canada. Publication of the first Sustainability Report of Sonae Indústria.

Table 2.1 – Chronological Overview

2.4 EMS Pilot Plant

2.4.1 The Factory

Located in Low Saxony, Germany, surrounded by the cities of Wolfsburg, Braunschweig and Hannover, this factory is usually called, the pearl from Sonae Industria, it was all builded with Sonae Engineering, during the year 2000.

Nettgau's factory was the chosen plant to develop the project, first tests with this new EMS will take place over there. If it all goes well, and the way it is expected there will be a project rollout all over Sonae's universe. One of the most recent factories is certainly the biggest investment made by Sonae Industria that planned, projected, and built this factory, with its own means. It is a huge factory, but, like all other newborns, there is always a lot of work to do, to make it really efficient, despite modern equipment and people value and knowledge.

Figure 2.2 – Nettgau Plant

Company	Glunz AG (85% of its capital acquired by Sonae Industria during 1998)
Location	Strohmweg 1 - 38 489 - Nettgau - Germany
Activity	PB Line – OSB Line – Two Melamine Lines
Number of employees	355
Area	54 hm^2
Production Start	By the year of 2001

Table 2.2 – Plant Description

2.4.2 Nettgau Materials

In Nettgau, there are two different production lines, one of OSB and another of particle board. There are also two melamine facing lines.
With a production capacity of 1.077.500 m^3, this is one of the highly producing plant from the company.
In the next paragraphs there will be detailed the description from each material that involved into plant's processes.

Particleboard is the term used to define any kind of board produced from wood particles. To make particleboards you can choose a huge variety of sizes and shapes. To define the type of particleboard you can use a variety of terms that will define which kind of material it is made of. Some of those terms are, flake board (made with flakes), chipboard (made with chips) and OSB (Oriented Strand Board), which is made with strands. Generally in Europe, particle is used instead of flake, so we have what we call particleboard. In this text, looking just for product meaning, chipboard is the product, but he is usually called of particleboard too.
Refer that particleboards are bounded together, with a process of a synthetic adhesive addition and a consequent pressing stage, on high temperatures and pressures.

Oriented Strand Board (OSB) are multi-layered panels made from strands of wood of a predetermined shape (typically, 15 - 25 mm wide, 75 - 150 mm long, and 0.3 - 0.7 mm thick) bonded together with a binder (often water resistant) under pressure and heat. The strands in the outer layers are aligned parallel to the long board edge and to the production line. Where the strands in the core layer are often smaller and can be randomly oriented, or aligned, generally at right angles to the strands of the face layers. The European specification for OSB is EN300 OSB was first developed in USA based on patents dating from 1935 and later wood panels based on "veneer strips crosswise oriented". The 1st pilot plant in USA started experimental production in 1963. The 1st plant in Europe operated only in 1978. The growth in demand for OSB is second only to MDF. In only 35years, the market acceptance is complete and around 100 production lines with a capacity of 40 million m^3/year have been installed around the world. North America is by far the largest producer of OSB; 85% of the world's production in concentrated in USA and Canada. Europe operates 15 new factories with a total capacity of 4millions m^3/year. About 75 % of OSB is used in construction, 20 % for packaging and the rest for decorative and diverse purposes. The standards EN 300 and EN 13986 classify OSB in four classes: OSB/1 is for general purposes in indoor (dry), OSB/2 is load-bearing in dry conditions,

OSB/3 is also for load-bearing but in humid conditions and OSB/4 is for heavy duty construction in humid conditions. Irle, Barbu 56 OSB is usually made with thicknesses ranging from 10 to 32 mm. Often the most difficult test to pass for OSB/3 and 4 is the IB and MOR after Cyvling boiling and so manufacturers use moisture resistant resins like isocyanides (PMDI), phenolic based resins (PF, MUPF) or melamine reinforced UF resins (MUF). The MOR and MOE values observed parallel to the long panel edge are normally double those observed across the panel. This is an effect of the strand orientation in the face layer.

2.4.3 Description of productive processes

On the following pictures it is possible to understand the production cycle in each process.

The first picture is related to particleboard production and the second to OSB production.

PB

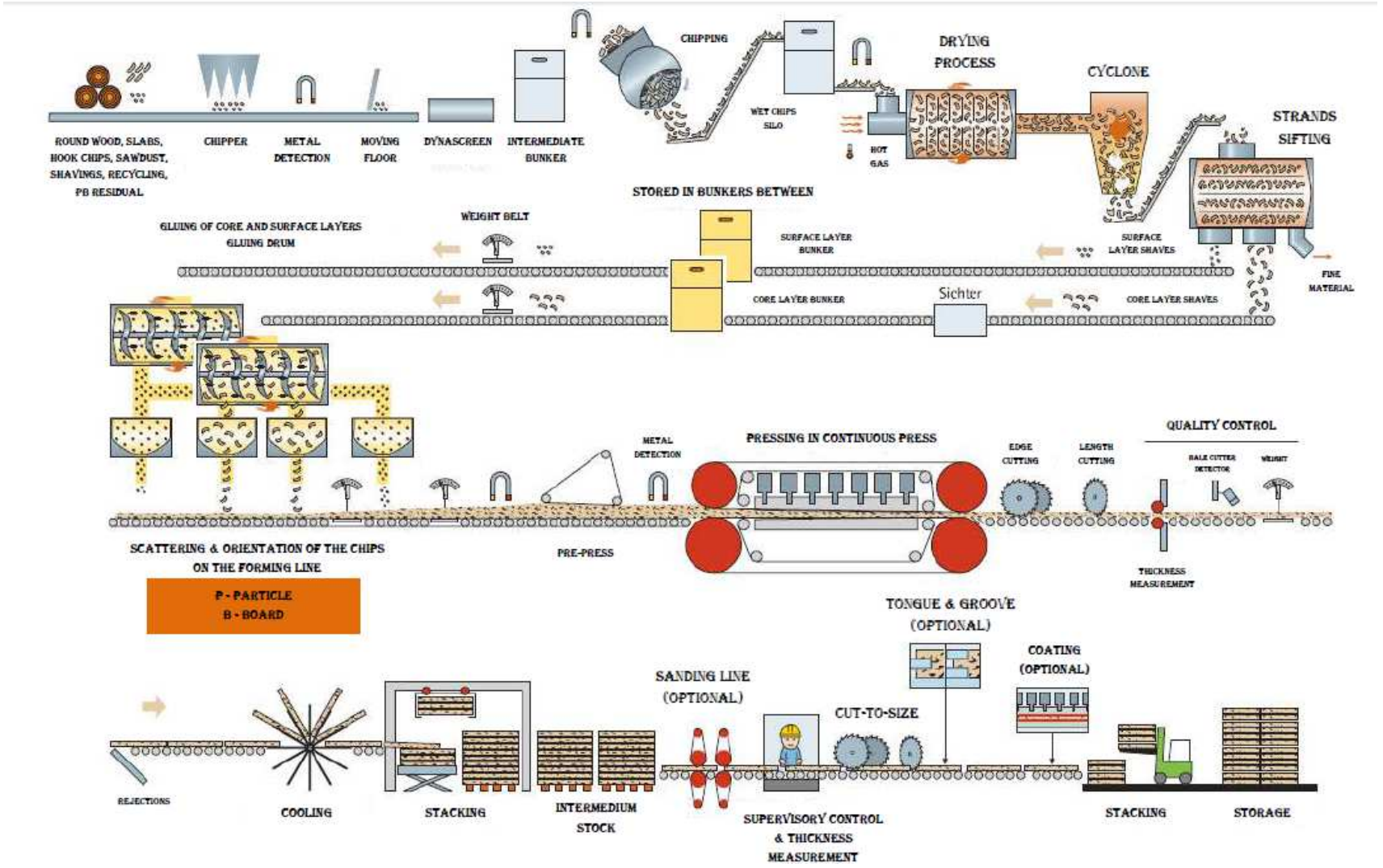
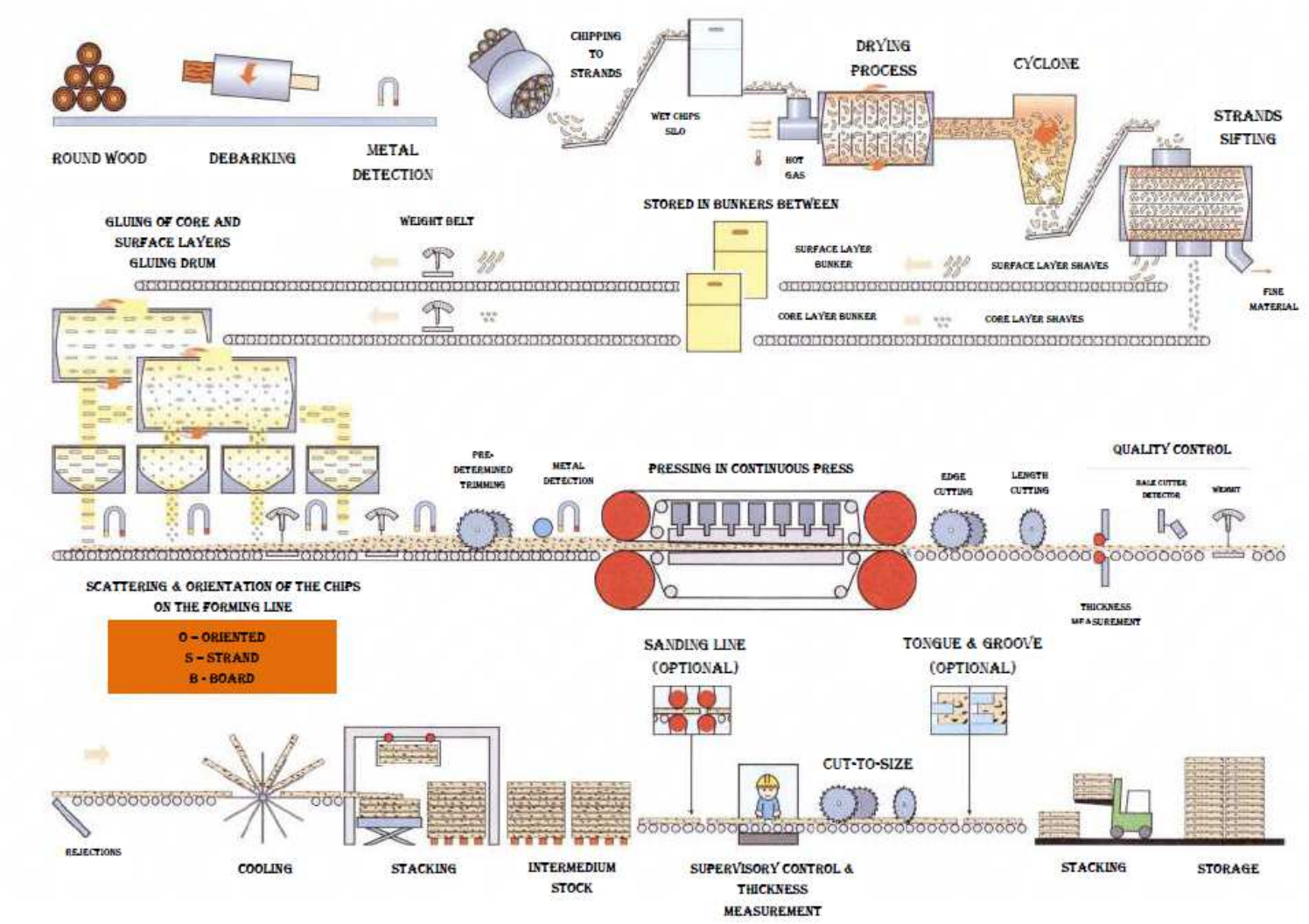


Figure 2.3 – PB Productive Process



OSB

Figure 2.4 – OSB Productive Process

Chapter 3

Energy Management

3.1 The value of Energy Management

The old fear from manufacturing industries managing energy and lowering consumptions is to loose quality on the final product. However, is impossible to predict it before you balance everything.
Companies pretend to reduce costs. Usually the easiest way is to downsize resources, not always with good results, and many times firing people, cutting on salaries and reducing labor quality. Those companies normally end with two choices, or they invest again in order to be competitive, or they close the doors definitely.
A viable way to reduce costs without losing efficiency is to start managing energy, that's why the number of enterprises creating programs of energy management is increasing every day.

With alternative energy sources available and brand new technologies being available in industry, the opportunities to save energy are innumerous. Obviously that if companies want to invest in technologies they will spend money and economic barriers will appear.
So, manage energy does not depends only in technical issues, it depends on how can companies implement technical changes considering economic limits.

Energy management is a continuous and endless process, some of the reasons are:

- Direct economic return, normally with short payback times;
- Reduce energy costs to produce the same material with similar quality. That is turning manufacturing companies even more competitive;
- Technologies are in constant change, there must be people responsible to be always researching and updating techniques;

- Prices are increasing every day, markets are not responding, that is one of the reasons that make companies being each time more interested in save energy and manage that resource properly.

The energy management program is detailed on the following sub-chapters, from the beginning till the completion of the implementation, after that the program will be always within company's management policy.

3.2 Organizational Structure

To start a program like this, is required an organization inside the company, it will involve different segments on the functional structure. In the picture X.X, it is possible to see in a basic level, where is the energy manager seated inside the company.

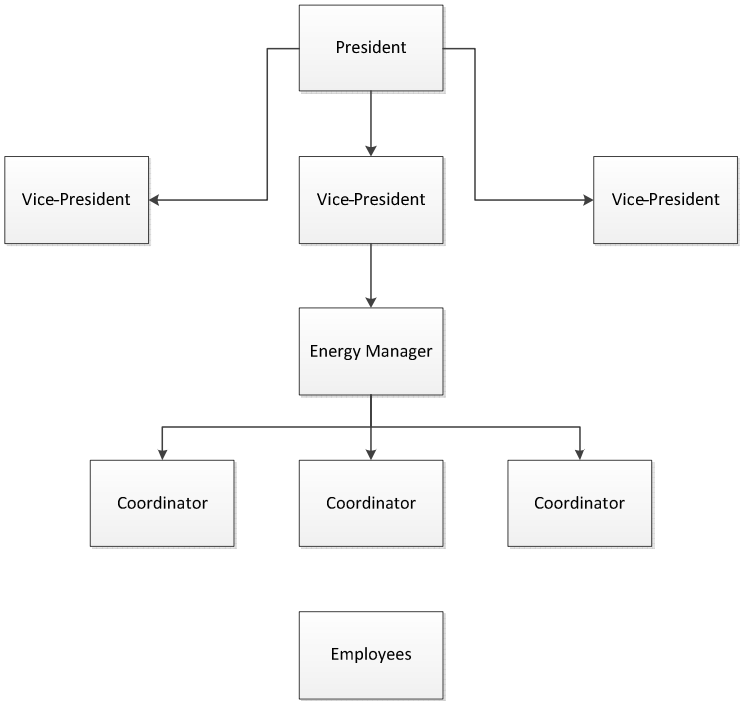


Figure 3.1 – Company Organizational Structure

Energy Manager, for sure the biggest figure in a program like this, many things will depend on him, he will make the things happen with his activity and continuous search for improvements. The energy manager is obviously important, but he shouldn't be alone, because even if he could conclude projects just by himself, the results won't last too long. It is necessary to involve everyone, to get surrounded by different people of functional structure, if he wants to turn his projects into real improvements. One of the basic principles is to establish a good and respectful relation with all his colleagues.

There are some roles that should be responsible of the energy manager, as example:

- Energy Management Plan Set up;
- Energy records should be established;
- Identify future energy needs;
- Search for financing sources;
- Recommend some energy saving manners;
- Apply himself his recommendations;
- Create an energy committee inside the organization;
- Evaluate projects efficiency;
- Build a communication platform of energy saving projects

Saving projects normally have its origins in just one person from the energy department, resulting on his research or even informed by any coordinator or operator about any interesting point. However, that are many projects coming from the corporate level, resulting on top management policy, and facilities management responsible, fact that brings advantages and some dangerous disadvantages, how is detailed in next topics:

Advantages:

- Project resources will be innumerous;
- Easiest to get support from top management;
- Reporting system could be unified;
- Budgets will be much higher;
- Energy and environmental legislation are determined at corporate level

Disadvantages:

- There are people working permanently on this areas, and developing a good work, so it could be found some resistance with fear to loose credits by their job;
- Normally pretending that different departments answer with the same speed, in terms of saving could create some internal problems.

Energy Team should complement the work from the energy manager. To build a decent energy team, the company should look to their energy manager skills, and try to fulfill the areas where the manager is not so good in order to create a sustainable team. As it was said before, this program needs to be a team associated, that works in different areas from the company and that will try to spread the energy efficiency principles all over the company. Here are some of the skills that should be part of the energy team:

- Technical Knowledge;
- Technologies acknowledgment;
- Capacity and skills to be a leader, to educate a team and to develop energy management strategies;
- Be aware of company economic policy, and understand perfectly payback and life cycle cost analysis;
- This is a global process, so everyone on this team should have communicating facilities and significant reliability inside the organization.

Employees are the most important pieces of this puzzle. They are on site, they deal with daily problems, with success, with rejections, and they have the sensitive knowledge of each little process inside a manufacturing site. That's why they should be totally involved in this process.

Many times the relation between the energy manager and the employees is limited to some posters with energy saving messages. That is not a good policy, the energy manager should pass at least ¼ from his time on site, near the employees, following their work, helping them, learning with them principally and when the relation between them is closer, maybe advice some new manners to the people that really make the factory work.

To get near the employees there are some psychological and motivational key aspects that should be followed, like:

- Help to release the motivation inside the factory staff;
- Be prepared to find interested and active workers, with energy projects, but, for sure there will be some that are lazy and will show resistance to change, so it is need a low profile leading with this;
- The amount of people involved around the projects will influence the energy savings.

There are many ways to increase employee's motivation. However, some of them are not so durable and consequently not efficient. A rank about motivation was made (Heresy and Blanchard, 1977), based in information retrieved by random workers. The results were the following:

1. Full appreciation for work done
2. Feeling "in" on things
3. Understanding of personal problems
4. Job security
5. Good wages
6. Interesting work
7. Promoting and growth in the company
8. Management loyalty to workers
9. Good working conditions
10. Tactful discipline of workers

From this list, it is easy to understand that recognition and relevance are maybe the most important factors in terms of motivation and that should be the focus for the ones that needs to establish a strong relation with factory staff.

3.3 Energy Policy

To implement energy saving projects, companies need to have a defined and solid policy related to energy questions. Energy manager will have authority to complain in corporate investments, with plants location, facilities, technological equipment, and human resources questions. Energy will be one of the key departments in a company, and for sure companies only win with that situation.

To set a new policy in a company or even to customize it, there are some indispensable points that could not be forgotten. They are listed on the following points:

Objectives are the main point of an energy policy, here could be found energy statements and procedures. The statements turns energy efficiency questions into top management

issues, what can even change policy with equipment acquiring, as example, considering that before the policy was, buy cheaper in order to save money, nowadays is usual to buy efficient, considering life cycle cost, what in the end could be even less expensive than the previous approach.

Accountability should define clearly, which are the financial conditions to implement any kind of project. It is necessary to set a list of people, procedures and departments, that projects needs to pass, since the idea appear till it is finally approved.

Reporting is a key aspect also. It does not make sense implement any kind of project related with energy, if there is no reporting in the following phase, where results could be studied. For sure that will be easier to the energy manager, to have reports where he can confirm targets and objectives, and at the same time, get closer from the employees, relating them with results, and consequently increasing their motivation level and willingness to help even more in future projects. Without report there is no developing.

Training should include all levels within the company. It is needed to set this on policy in order to create a respectful position from the energy projects, and to take people closer to those same projects, creating habits and increasing workers interest with questions like this.

3.4 Planning

Professionally it is common to hear that if there is no a proper plan, there are no successful results. Obviously that with a sustainable planning for a project, there are, in the beginning, more probabilities to be succeeded.

To have a perfect plan, it is necessary to involve everyone that will be part of the project, in the planning phase, and get the team together from the beginning. This way, there will be a big commitment from each actor, as they made part of project since the early stages. Success will be most desired end.

There are some guidelines for planning, which could help the organization to be succeeded.

Problem definition — the problem is clearly defined to members of the group.

Grouping — Divide large groups into smaller groups of seven to ten, then elect a recording secretary.

Silent generation of ideas — each person silently and independently writes as many answers to the problem as can be generated within a specified time.

Round-robin listing — secretary lists each idea individually on an easel until all has been recorded.

Discussion — Ideas are discussed for clarification, elaboration, evaluation and combining.

Ranking — each person ranks the five most important items. The total number of points received for each idea will determine the first choice of the group.

3.5 Audit Planning

To a perfect understanding from a plant situation in different levels, there will be needed a preview phase for auditing. The results from different audits should help the energy team to organize a plan properly, focusing on areas that are more relevant in terms of cost significance and productive efficiency. From an audit process, results a huge number of opportunities, that should be analyzed and treated properly, by the energy team, and when necessary with the employees and top management.

There are some common types of audit that can be helpful to define improvement measures and to create a priority database, where energy team should be focused on the planning phase. Here are some of them:

Motors;
Lighting;

Water;
Controls;
Steam System;
HVAC;
Compressed air;
Tuning-Operation-Maintenance;
Employee Suggestions

To perform audits, there are two possibilities, which are, a performance contracting, from an audit specialized team, or the creation of an internal audit team, which will be responsible for all the process.
Each one of these possibilities has advantages and disadvantages, which are listed in the table.

Performance Contracting

Advantages	Disadvantages
Company won't need to invest beyond the audit partner;	Technical resources will be from the contracting company, fact that can limit the work sometimes
Company's human resources won't be necessary beyond the energy manager and financial team;	Contract an organization that might not have enough skills to compete the audit properly
	The contracted organization could be not interested in low cost projects

Table 3.1 – Performance contracting

Internal Audit Team

Advantages	Disadvantages
There is the possibility to allocate the best human resources from a plant in their specialty areas;	To take full profit from the internal audit team there will be necessary some additional resources inside the organization, and in the end, contract an external company could be sometimes preferable
The range from the audits will be larger, and there could be identified both low cost and high investment projects.	
The audit can be part of the training phase of the energy management program	

Table 3.2 – Internal Audit Team

3.6 Educational Planning

Ignorance is the adjective that fits best concerning energy education. Perfectly normal! Our society grew up in a world where this resource was something indispensable and there was necessity to control how, when and why it was used.

The fact is that energy consumption is a problem, and that is why is important to educate properly the people inside the organizations. To educate correctly and directed to each different group within a company, it is needed to divide this step for the three main groups of any organization, management, energy team and employees.

Management training is not the easiest task for sure. It is not easy to steal some hours of a manager. However there are some ways that can help the energy manager to educate and train this segment of the organization. One of them, is to collect some articles, news and presentations, and take it to managers, they will read it for sure. Obviously that is crucial that the energy manager is part of the business planning and integrates the management department, in order to pass his ideas often, and in some way, educate top management.

Energy team training is the most important phase of the educational planning, this is the main group, and everyone that makes part of it should have a perfect knowledge about energy management, and all the points that concern to this program.

There are several ways to train this group, and they are available in various forms:

- Self-Study;
- In-house training;
- Short courses offered by associations;

- Intensive university courses in energy departments

Besides the points above, it would be really important in big companies with many operating plants, to promote a congress in a predefined place, directed to energy, in a fixed period of time, and where all the energy team should be present, to shares ideas, successful implementation, and different perspectives to look at the same problem. That is a way to train the energy teams, and the management groups, that normally don't miss these occasions.

Employee training is a challenge for the energy team. To get near them it is needed to take their morale up, and let them know how important they are in this kind of question. To teach them it is not necessary a very theoretical analysis. Short and simple information are preferable. The most appropriate training program should include:

- Energy conservation on their own houses;
- Basic concepts of electric energy;
- Basic concepts of energy systems;
- They should apply the acquired knowledge on the respective jobs.

3.7 Strategic Planning

Strategy is the key to success of a program like this. The objective of an energy management program is to achieve energy security, to get it there are different strategies that need to be followed, as example, reliability, efficiency, low cost/no cost, funding and awareness. On the next pictures, there is a description, with strategy, programs to implement and actions to be performed.

Reliability

Maintenance Program	Modernization	Operations	Training	Contigency Planning
• Develop maintenence plan • Develop preventive maintenance plan	• Computerize data and analyse trends • Evaluate EMCS • Start a steam trap survey program • Review insulation opportunities	• Develop an operating procedures manual for major energy using pieces of equipment • Examine operational schedules for potencial energy savings	• Develop training plans for: - Operating Procedures - Maintenance - EMCS - Steam traps - Other technical topics	• Develop a contingency plan for electric and gas utility cutback • Determine alternative energy sources • Establish a shutdown procedure

Figure 3.2 – Reliability Strategy

Efficiency

Plant Property Evaluation	Measurement	Control	Energy organizational efficiency
• Develop an audit program • Develop a plan for updating inefficient equipment • Establish proper size for equipment, such as motors	• Establish permanent instrumentation for energy measurements • Procure necessary portable instruments • Develop an energy reporting and evaluation program	• Assure proper functioning of existing controls • Develop a no cost/ low cost program for controls • Evaluate and install EMCs where economically feasible	• Enhance stability of energy council • Amend the energy management organizational structure as necessary for increased efficiency • Establish a corporate level energy management team to assist lower organization

Figure 3.3 – Efficiency Strategy

Low cost/No cost

Alternatives

- Develop fuel switching capability for oil and gas

Negotiations

- Electric utility
- Gas utility
- Purchase coal by BTU
- Purchase in bulk
- Combine purchases with other facilities

Time-of-use

- Establish an electrical demand control system
- Maximize use of Off peak electrical energy

Elimination

- Eliminate excess lighting
- Reduce steam pressure where psi provided not required
- Audit for equipment using energy, but no longer needed, such as transformers, motors...
- Audit hot water temperatures for possible reduction

Figure 3.4 – Low Cost Strategy

Awareness

Training

- Management training – Goal and strategy
- Energy manager and coordinator training - Specific objectives
- Operator training – Basic energy
- Identify and publish available training resources

Communication

- Publicize energy activities
- Network of energy comitees
- Scheduled meetings of energy council, building monitors and command council
- Annual energy conference for all involved
- Hotline for energy suggestions
- Suggestion box for energy ideas

Behaviour Modification

- Awards and recognition program for individuals
- Provide a savings kickback to departments
- Develop a plan to give credibility to top management for energy efficiency
- Develop an accountability plan for users

Program Evaluation

- Develop a feedback plan
- Establish team visits to access progress
- Establish an energy index
- Create competition

Figure 3.5 - Awareness Strategy

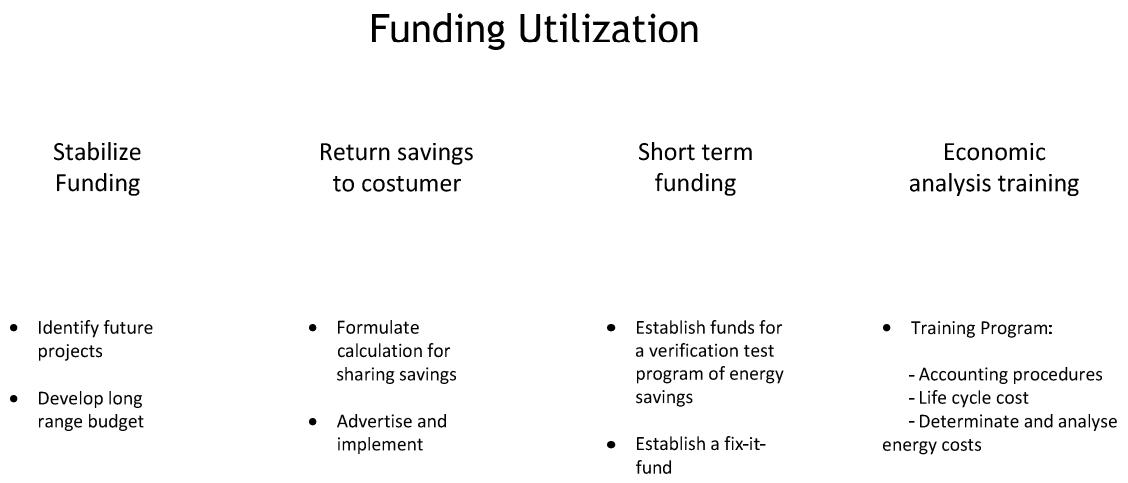


Figure 3.6 – Funding Utilization Strategy

3.8 Reporting

This topic is a challenge for the energy team. If there is an energy management program, for sure that there will have to be reports associated. The objective is to show the results for those whom are working to get them, and like that, develop the interest on energy, and the willingness to get better as time goes by.

For sure, a report to top management, won't be the same that the report to the operator of OSB production line. Reports need to personalized, simple, without long description, containing images, graphics, benchmarking and simple results. The objective is to create something that will be side by side with production reports, and in the future will be a daily tool for those who really want to be efficient.

In this project, Sonae has that same objective, when they pretend to have a common EMS for all plants. The image below show the reporting purposes of this new energy management system, as an example of this section:

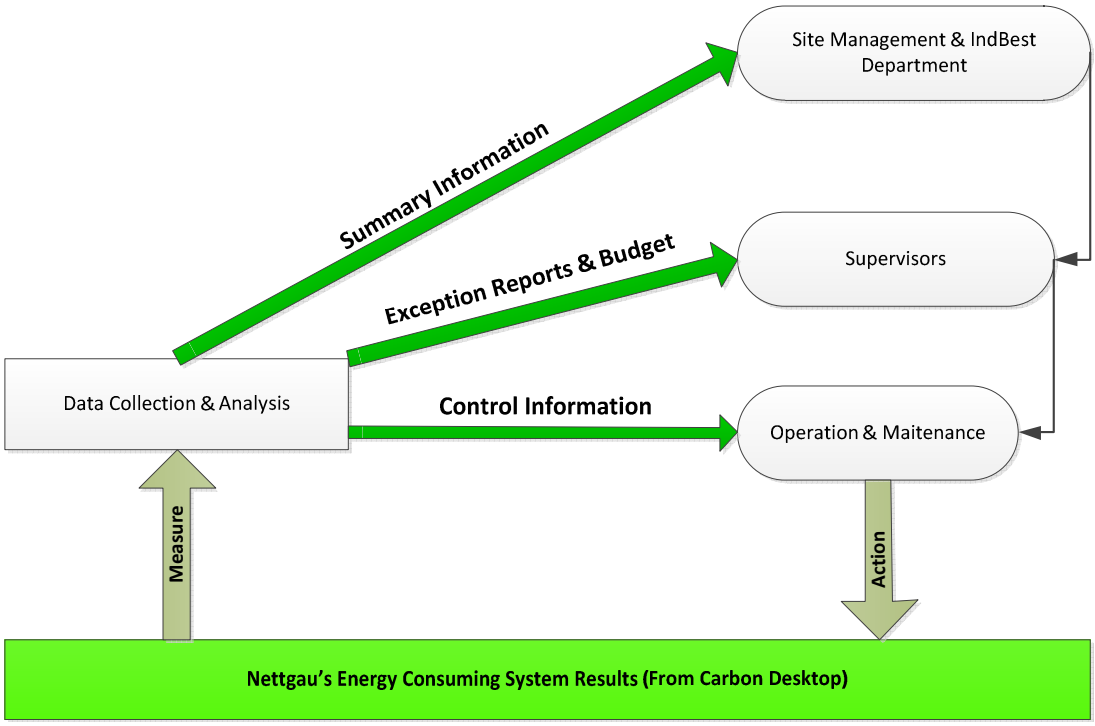


Figure 3.7 – Reporting System

The picture suggests that in Nettgau plant, there will be three different types of reporting, for each factory department, which is perfectly normal since the operator won't care about summary information, with a huge quantity of numbers and extensive KPI's.

Concluding, without report it will be difficult to improve because you cannot see what is changing, where is changing and why it changed. However, even with reports, there are a lot of concerns that should be taken in consideration in order to have the reporting system as a user friendly tool, that workers will make use of and not as just one 'boring' measure from the energy team.

Chapter 4

Energy Management System

4.1 What is an Energy Management System?

To understand the meaning of energy costs and consumptions is necessary to have a system to collect, analyze and report energy data. This way the organization will have the possibility to look inside energy resources and identify possible saving opportunities. EMS, or Energy Management System, it's a factory level monitoring and controlling system, that works as a fundamental tool of an energy efficiency program, an EMS provides a framework for managing and continuous improving of organizations policies, processes and procedures.

An EMS could be extremely useful, as example, in public buildings, as Shopping Centers and hospitals, in our homes, for a better energy usage, or even around a defined area inside a big city in order to reduce municipal costs with energy consumptions.

There are many ways to install an EMS. Nowadays the wireless technology is appearing as an interesting solution for this kind of system. However, there are some problems related with signal strength that are not so easy to solve. Instead, cabling is the common solution, and the one that is usually installed in factories like this.

Once installed, the energy management system needs a team to explore it, and take profits from its capabilities. Instead, the organization will lose all the many that invested to install

it. So, to cover the investment done in the EMS, companies need to assure that, there will be someone on site, possibly a team, which will work with EMS software, in order to analyze unexpected daily events, to be ready to contact anyone within the factory if they think that something is wrong.
This team will also develop reports, from each different process and directed to different departments, possibly in a daily base, with the purpose to turn energy reporting into a key tool of a day to day work methodology.

Nowadays is usually to follow the energy policy of "Plan, Do, Check, Act", in order to improve energy efficiency. Obviously, that the only way to do this is having an EMS on site. On the picture below, it is exposed the influence of monitoring systems on energy efficiency developments.

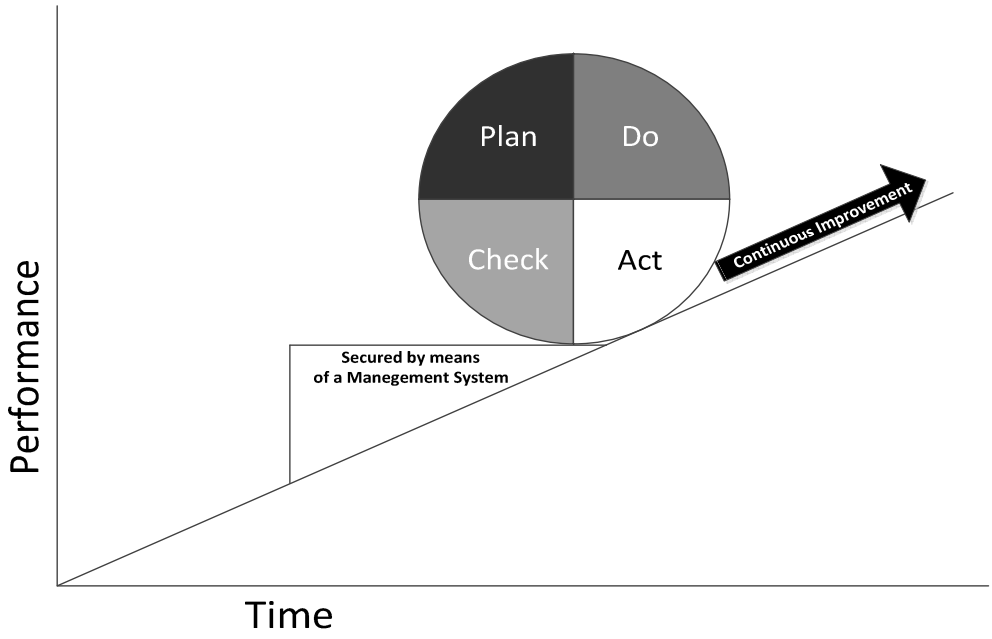


Figure 4.1 – Plan/ Do/ Check/ Act Methodology

Analyzing this picture, it's easy to understand the importance of an EMS, sustaining the "Plan, Do, Check, Act" methodology, increasing performance as time goes by, driving to what is called continuous improving.
This methodology has different perspectives within an organization. It is possible to divide them in two major groups: Managerial Department and technical department. Each one of these groups will have their own individual tasks, and is pretended that in the end, they work as a whole. On the next list, there is the responsibility of each group in each stage.

Managerial

- **Plan**
  - Policy / Goals / Targets
  - Resources
- **Do**
  - Training
  - Communication
  - Control equipment, systems and processes
- **Check**
  - Corrective / Preventive actions
  - Internal Audits
- **Act**
  - Management Review

Technical

- **Plan**
  - Energy data management
  - Assessments
- **Do**
  - Energy purchasing
  - Design
  - Projects verification
- **Check**
  - Monitoring
  - Measurement
- **Act**
  - System performance

Without an energy management system, these points could not be considered, at least with this type of detail. Refer that both managerial and technical departments are fundamental, the complete themselves.

4.2 Monitoring and Targeting

The principle, "*you can't manage what you don't measure*", is a key value for lean management. Energy management is not exception, the only way to improve is to analyze, and to analyze is necessary to measure.

These two techniques allow organizations to reduce waste, consumptions and consequently costs, related with energy. Processes and procedures are improved, the optimization is continuous.

Monitoring refers to on time readings and further analysis, relative to gas, steam, refrigeration, electricity, fuel and other meaningful variables. Targeting is the result of managerial objectives to improve quality, reducing consumptions and consequently, costs.

Sometimes, energy consumptions are related to productions, in order to get specific consumptions. The advantage from this kind of policy is the possibility to target quality and consumption, in order to optimize each one of them and taking as result, lower energy consumptions for the same production quality target. That is Sonae purpose with this EMS, on the following chapter it will be properly detailed.

Program like this, always improve operations, and usually results in an energy cost reduction from 10% to 20%, normally after two years.

To a successful implementation, there are guidelines to follow. On the next picture is possible to understand different stages from this process and the meaning of each one of them. It is a continuous process, where the main objective will be the reduction of energy consumption.

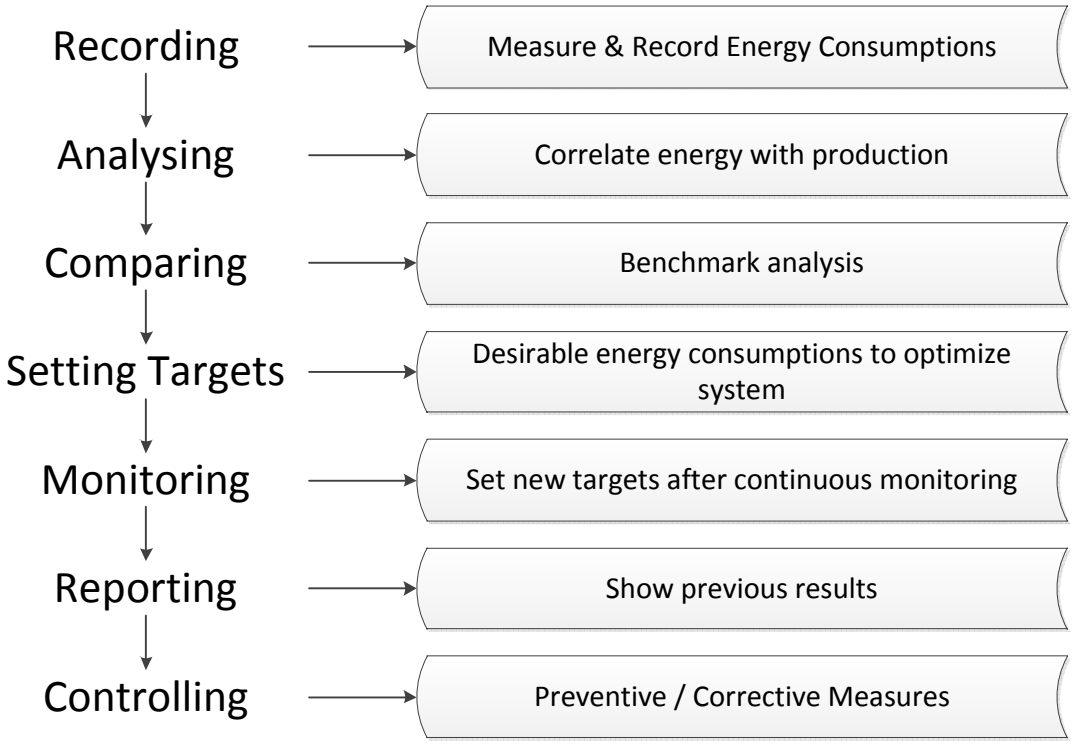


Figure 4.2 – Monitoring and targeting basic Guidelines

To set new targets and objectives, there are some sources, easy to access, that can be very helpful. As example:

- Monitor sub-metering data to check system level performance;
- Establish a bridge between EMS and utilities cost department;
- Create a benchmarking database, comparing different plants from the corporation or ever similar plant from the concurrence.
- Identify all different variables that make part of each one of the productive processes, in order to a better understanding of their specific consumption values.

4.3 Energy Consumption vs. Production

To monitor and target, is necessary to be aware of the reasons that makes energy consumption vary so much, only after a perfect knowledge about oscillations cause and meaning, will be possible to take profit from the energy management system.

Let's consider the values for energy consumption (kWh) and production (m^3), resulting from Sonae Indústria's energy reports. This data is relative to particleboard production line, during the years of 2010 and 2011, in one of the company's factories. This will be the data used to plot the next graphics.

Month	*Energy Consumption (kWh)*		*Production (m^3)*	
	2011	**2010**	**2011**	**2010**
January	5.487.875	5.797.580	44.475	48.028
February	5.023.012	5.112.212	46.092	46.968
March	5.704.697	5.737.168	49.421	50.829
April	5.248.451	5.123.172	46.509	42.670
May	5.784.720	3.768.962	51.127	27.527
June	5.634.568	4.625.716	49.368	37.073
July	3.564.335	4.047.600	25.432	34.439
August	5.440.721	5.970.830	51.728	52.887
September	5.740.125	5.794.610	49.465	51.951
October	6.058.936	5.861.890	51.582	50.446
November	5.590.451	5.847.150	46.324	49.395
December	4.934.027	4.701.175	41.585	32.435

Table 4.1 – Energy Consumptions plus productions at the plant during 2010 and 2011

Energy consumptions, energy costs and production data, are the main variables that need to be related. Energy costs are associated to the consumptions and these are related to production data. To present it properly, a graphic should be the main tool, since is easy to understand and to extract conclusions from what is happening around the plant. On the next pages will be plotted some graphics that could be useful tools to the energy team. The first one, relates energy consumptions from each month of the years referred on the table.

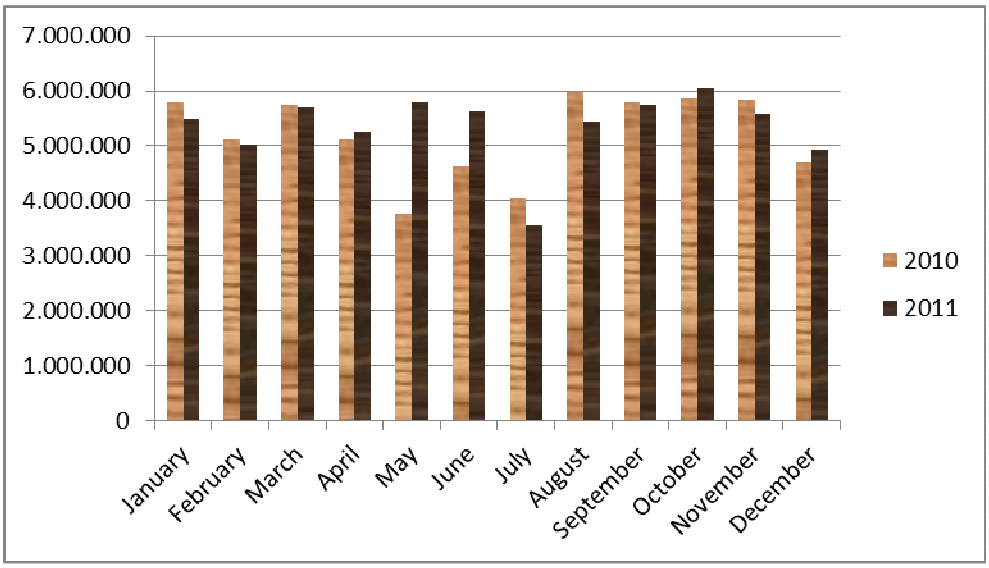


Figure 4.3 – Energy Consumptions

From graphics like this is possible to understand the evolution of energy management programs. However it is not 100% reliable, imagine that the plant increased dramatically the production. Obviously that energy consumption will rise too. That's why is so important to mix productions with consumptions to avoid false conclusions.

One of the solutions to fight these uncertain results is to plot energy and production on the same chart, using two y-axes for example. One of the conclusions that we get immediately is that both charts, seem to be "tracking" each other as shown in the next image.

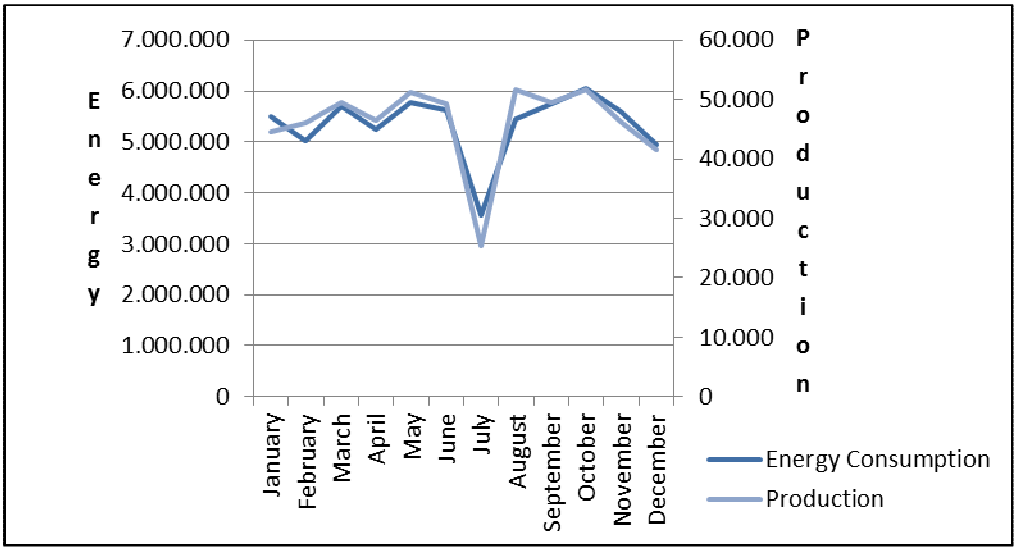


Figure 4.4 – Energy Consumption and Productions Chart during the year 2011

However, with a deep analysis, it is possible to understand some deviations between the charts. For example, during the month of august, there is a curious behaviour, the production (m^3) raises faster than energy consumption. This fact is probably a consequence of a good energy efficiency policy. On the other side, this kind of representation allow us to identify points of waste.

For most of the companies, energy is directly linked with production. It makes sense to relate both in one indicator, that's why Specific Energy Consumption (SEC) is calculated, which is energy consumption per unit of production.

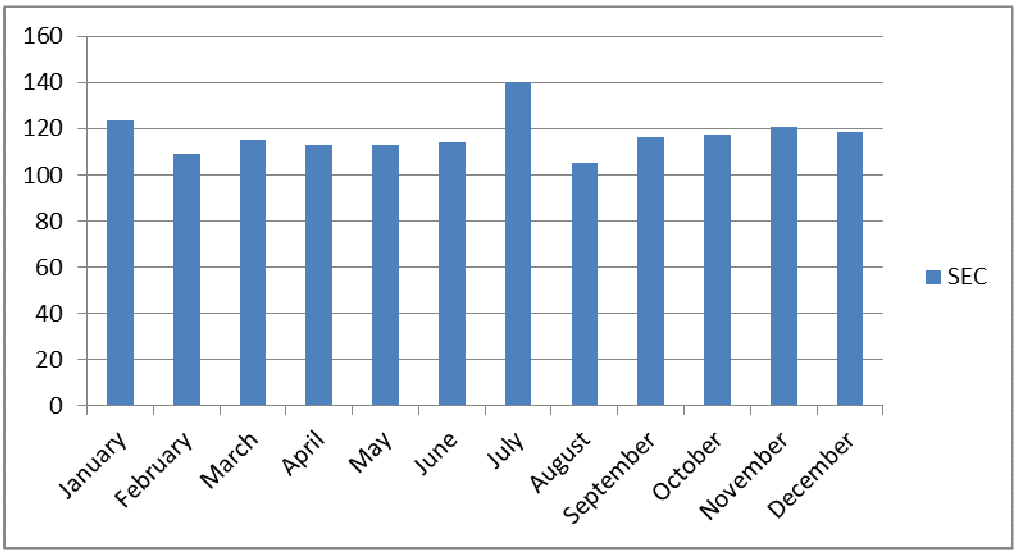


Figure 4.5 – Specific Energy consumptions during the year 2011

To better understand the relation between energy and productions, it's usual to plot one against the other, and then, add a trend line to the respective chart. This procedure is called regression analysis, and is represented on the next chart:

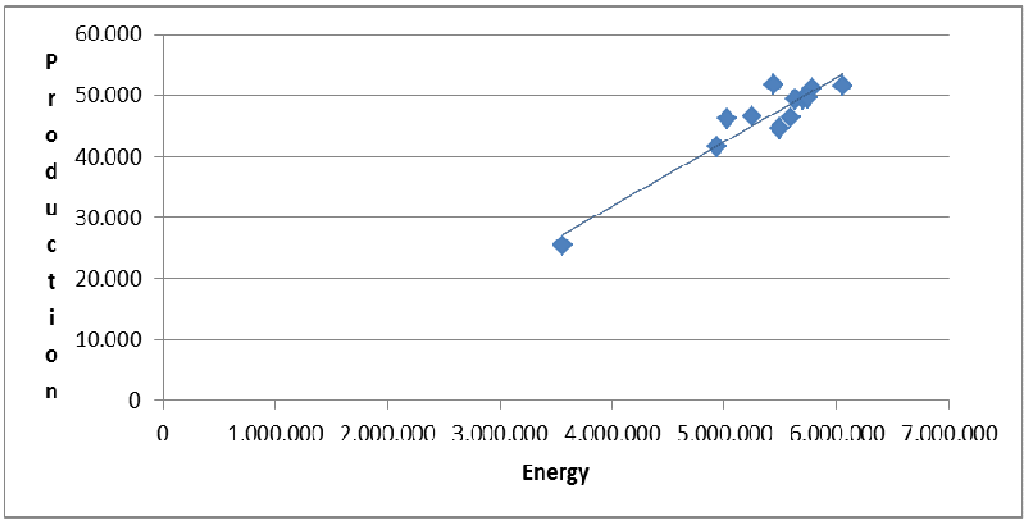


Figure 4.6 – Regression Analysis between Energy and Production

It could be used to derive a benchmarking indicator for the next year's consumption. Analysing this types of charts it's possible to understand the potential to improve results, considering that if there is no much dispersion from the trend line, the energy efficiency results are already in a good level.

Chapter 5

SONAE Indústria's Corporate EMS Project

5.1 Which are the company pretensions?

This project consists into an implementation of a common and global EMS platform for online monitoring of energy performance, with the following objectives:

- Create daily energy awareness at all levels of operation;
- Involve main energy users for a more efficient way of using it (with targets);
- Improve energy efficiency on a daily base;
- Improve energy management behaviors supporting ISO 50001 certification.

The application of the system was planned to be implemented in 1 pilot location, more specifically in Nettgau, Germany, where the traineeship was made. In the future, after approved, this project will be replicated in the remaining plants, according to a priority list.

With the implementation of this system there are some benefits that are expected to improve energy efficiency around Sonae Indústria's universe, benefits detailed in the list below.

- ✓ Plant and sector daily follow up of performance against target;
- ✓ Daily automatic energy performance reports for operation;
- ✓ Daily awareness on energy consumption;
- ✓ Online System;
- ✓ Integrated system for analysis, document and visualization of energy data on a daily basis;
- ✓ Document and KPI of biomass usage for thermal energy production;
- ✓ Specific energy consumption structure;
- ✓ Best practices database;
- ✓ Cumulative savings information;
- ✓ Benchmarking by plant and sector;
- ✓ Carbon Emission.

To achieve all these targets, a third part was connected with the project. The provider of the EMS is a British company, specialized in energy and carbon advisory services, that was chosen after a big research realized by energy team members from SONAE Indústria. They were the

selected company as they presented the better relation between price and quality. There were some requirements established by the energy manager that needed to be covered by system's specification proposal, the requirements were the following:

- Data from a number of metering points, utilities or tariffs;
- Track electricity, gas, fuel oil, water, steam and temperature;
- Energy Consumption (kWh/m^3) by site, product type or characteristic, and process line;
- Benchmarking comparison between sites and assets;
- Customized and automatic reports (by plant, product, process line, equipment, period);
- Regression analysis;
- Real-time meter reading;
- Multi-language.

The architectural concept of this project is represented on the next picture:

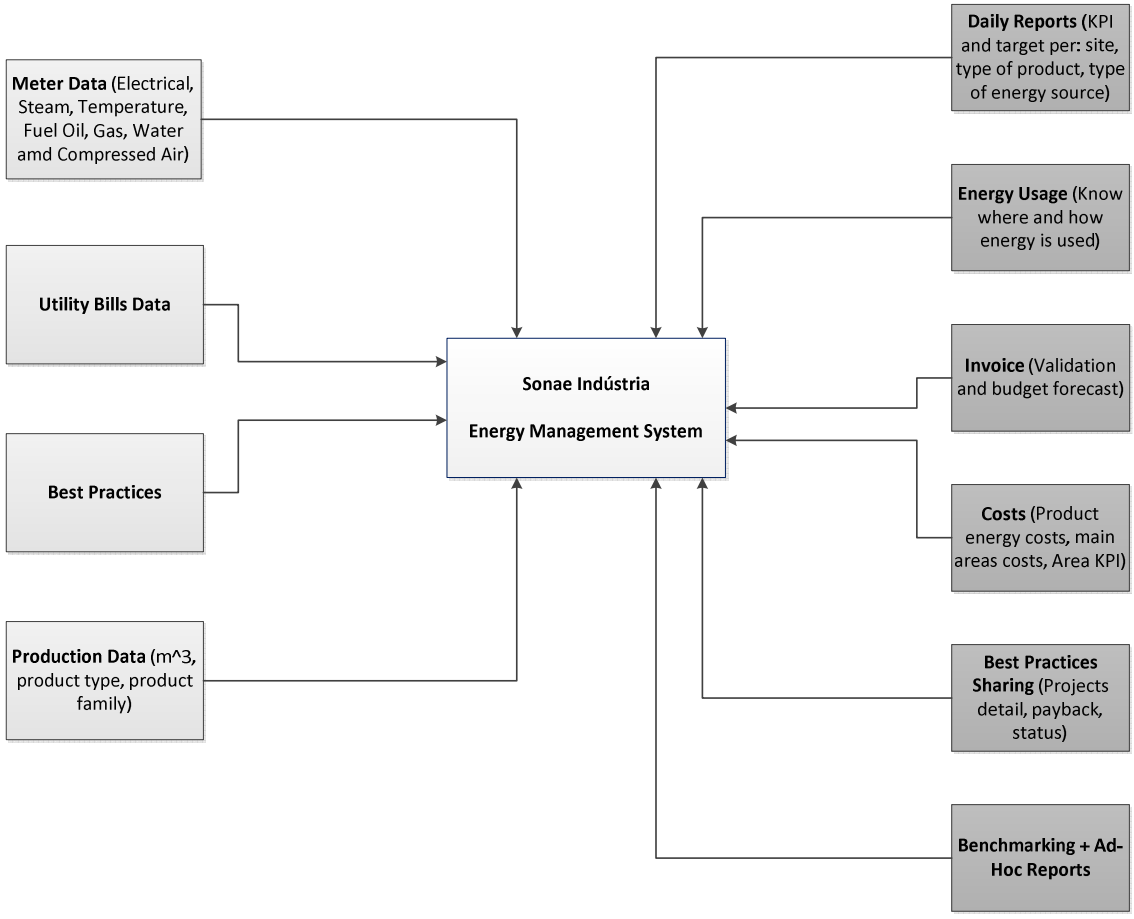


Figure 5.1 – Project Concept

5.2 Project Setup

After closing the negotiations, it was time to define a team to follow this project and a plan to guide the team during the implementation. On the next picture it's possible to understand the way the team was divided, which were the main functions from each piece of the puzzle and how was the connection between the different parts.

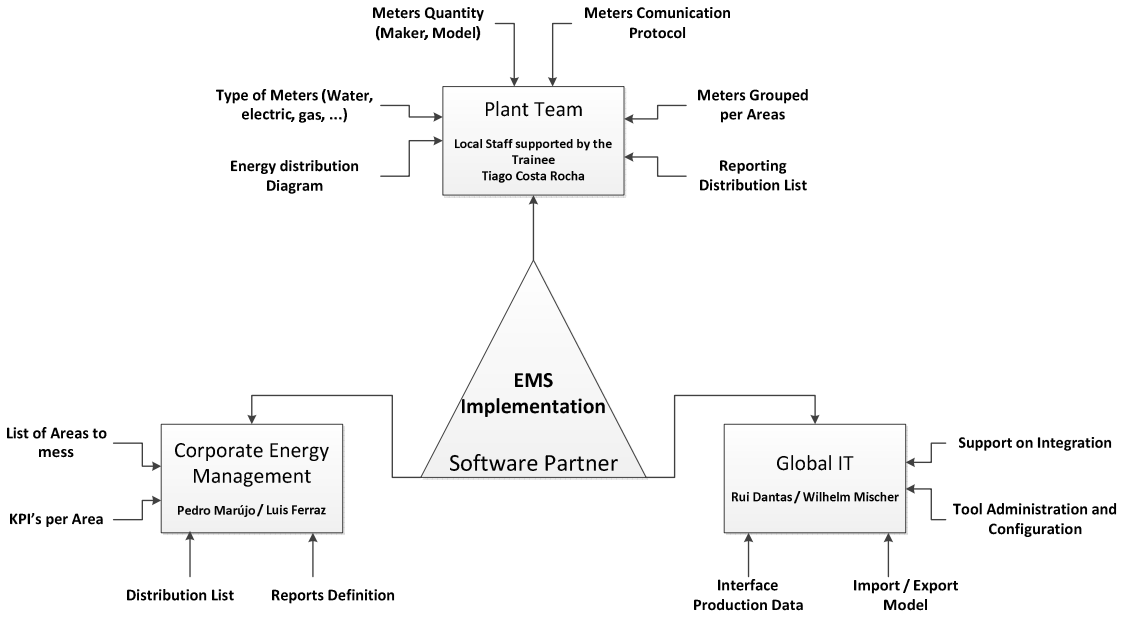


Figure 5.2 – Project Main Tasks Division

The primary task was the identification of the meters structure around the plant, know how many meters were already installed, where were the situated, what were the measuring. To an organized and easy understanding list, the next parameters were defined:

- Facility (PB, OSB or Melamine)
- Area (Wood yard, Dry Particles Preparation, Press line, …)
- Location
- Meter ID
- Address
- Type

Here is an example of this classification:

Facility	*Area*	*Location*	*Meter ID*	*Address*	*Type*
PB	Wood yard	SU1	NE01 1P1	1	Multimess

Table 5.1 – Example of meters shortlist

A list of almost three hundred meters was made. Although, the proposal that was presented, had defined only sixty meters to place 30 Dual-Channel wireless transmitters provided by the energy consulting company.

This wireless transmitters results from sophisticated solution, which consists in a system without cable, working with the little transmitters connected to the meters, receiving pulses and sending to one concentrator through two repeaters, then, the concentrator accumulates information and every 15 minutes it sends the data to the EMS Server, placed in UK, on the headquarters from the provider, that updates the results on time in a website, where all the team will have access. The next diagram clarifies the system:

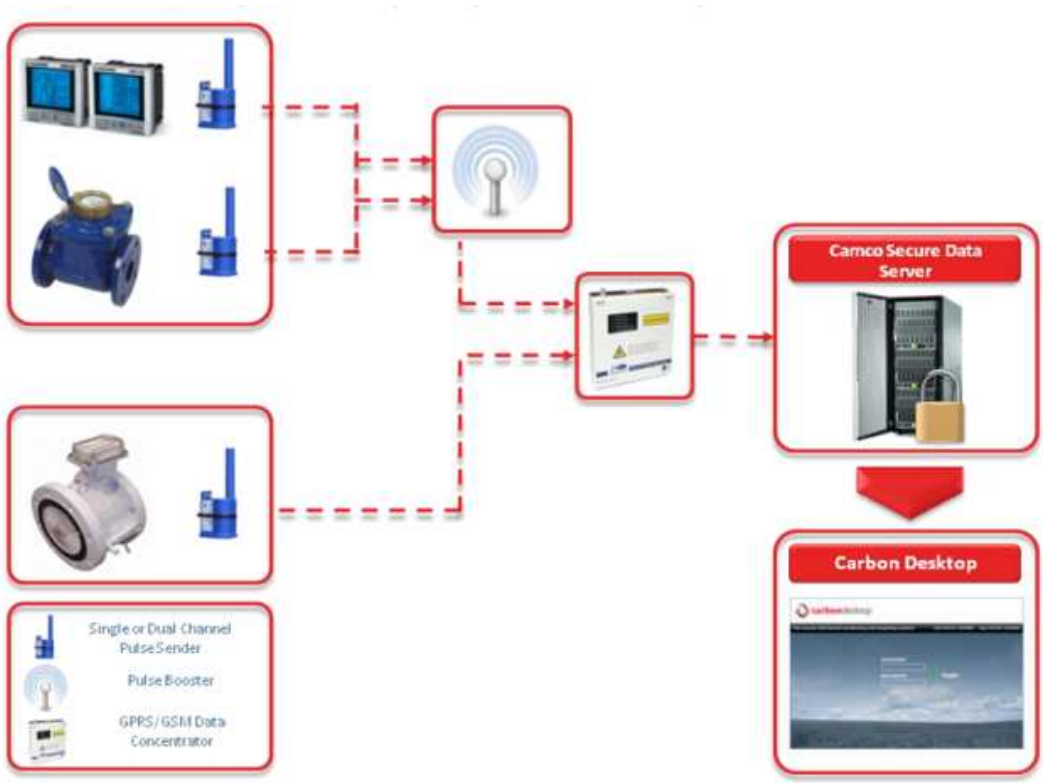


Figure 5.3 – System Architecture

In consequence of this fact, it was necessary to pass from 300 points to 60 points. The main factor to realize this shortlist was the level of consumption of each meter, and the area it

was related to. It couldn't be forgot that this project is to replicate, so, there are some factories of the company that are older and less meters and less points to mess. In consequence, the choices need to consider the areas that are common to the majority of the plants in order to benchmark between them in the future.

After that, it was necessary to install the wireless transmitters in the respective meters previously selected. This installation was a bit complex, once that the existent meters were not prepared to send pulses, therefore an adaptation needed to be done. The next paragraphs explain how it was possible to get pulse output from the existing meters.

The solution found was the connection of Optocouplers to each one of meters that will be sending information.

Optocouplers are devices that use light to transfer signals and data from one system to another within a piece of electronic equipment without a direct electrical connection. They are both housed in a single package with a light-conducting medium between them. This allows the total electrical isolation of electronic circuits while transmitting information from one voltage potential to another.

In this case, of Nettgau plant, we will have after Optocoupler installation, the following process:

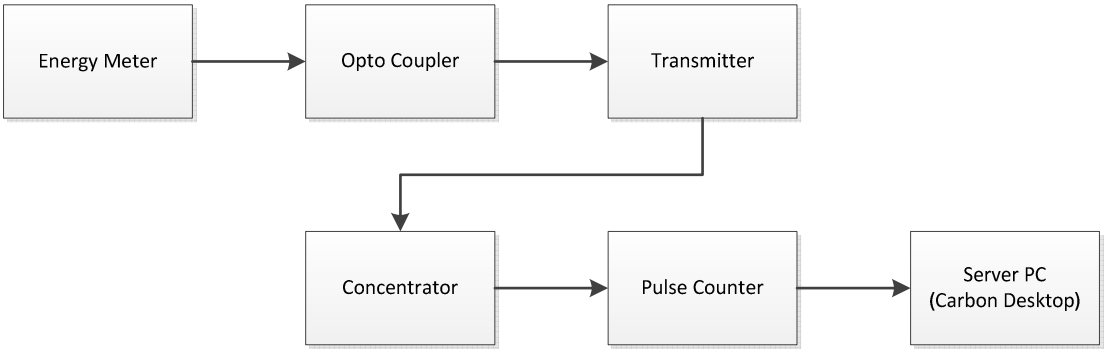


Figure 5.4 – Workflow of pulse signal

The next shows one meter prepared to send pulses and ready to be connected with the transmitter.

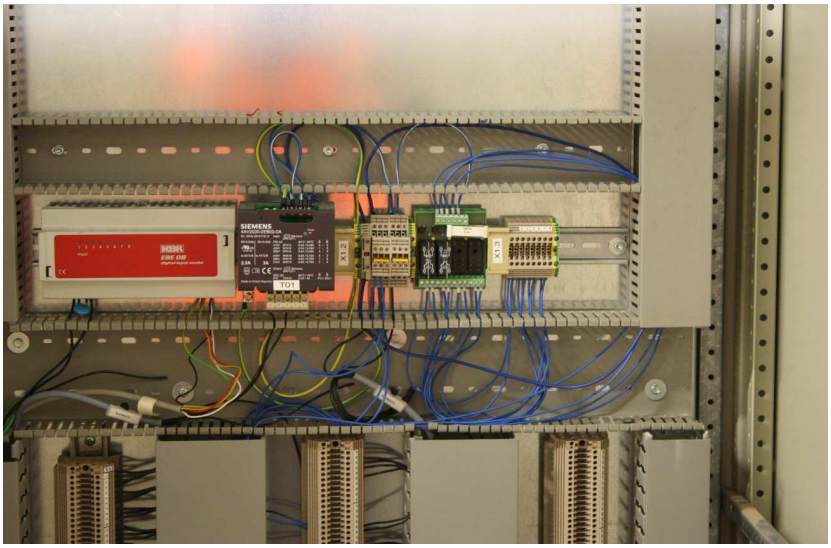


Figure 5.5 – Optocoupler installation

The transmitter connection was relatively easy after the work done adapting the existing meters.

Later, all the equipment from the provider was received on site, and installed by the local team. The material that arrived on site was:

- 29 Dual Channel Wireless Transmitters
- 2 Single Channel Wireless Transmitters
- 2 Boost Repeaters
- 1 Concentrator

After that, the transmitters were placed in the respective meters, and the repeaters were installed in two strategic points to allow the concentrator to get signal from all the meters. The concentrator was placed on the server room, which was sensitively on the middle point of the plant, what was good for the wireless transmission effectiveness.

The next picture shows some meters already installed and ready to start sending information.

Figure 5.6 – Transmitters Installation

After all this steps completed, the system was ready to be started and tested. Only after that the problems that may exist would be discovered.

5.3 Project Startup

Ready to start, the repeaters and the concentrator were plugged in, and the EMS was ready to be explored. Although it wasn't working perfectly, two problems appeared and delayed the beginning of the measuring analysis.
The first problem was that the repeaters weren't working, and it was needed to send them back to UK, to be fixed. The reason pointed to cause all that was the different frequency that they were going to work in Germany. Fortunately, one week and a half later, both repeaters arrived on site working properly.
The second and most difficult problem was to configure the concentrator. Pass through SONAE's firewall and synchronize with time server, made us loose some time in relation with what was expected.

With the problems solved, the online tool was already receiving data, and it was finally possible to start measuring in order to manage.

The system will be updated in real-time, so one of the things that was necessary to do, was to advise the local team, in this case, the energy manager from the plant, to follow the results at least once a day, in order to understand the evolution of the consumption during a working day, identify and understand different occurrences that happens with the machines working.
It's obvious that without a careful and constant analysis of the results, it will be impossible to improve.

Unfortunately, it is not possible to present here, graphics and values with specific consumptions. That's because, the production data, that will be place by the IT department was not properly organized yet. There is a huge production database already placed on the system, but it is needed to divide it by product, type and thickness in order to get logical results for what the management pretends. So, on the next pages, the system will be represented and a few images from some critical consumers will be shown, only with energy consumption.
It's a web based software, where the responsible people will be allowed to access, with a username and a password, it will be available every time and everywhere. The login interface is shown on the next picture.

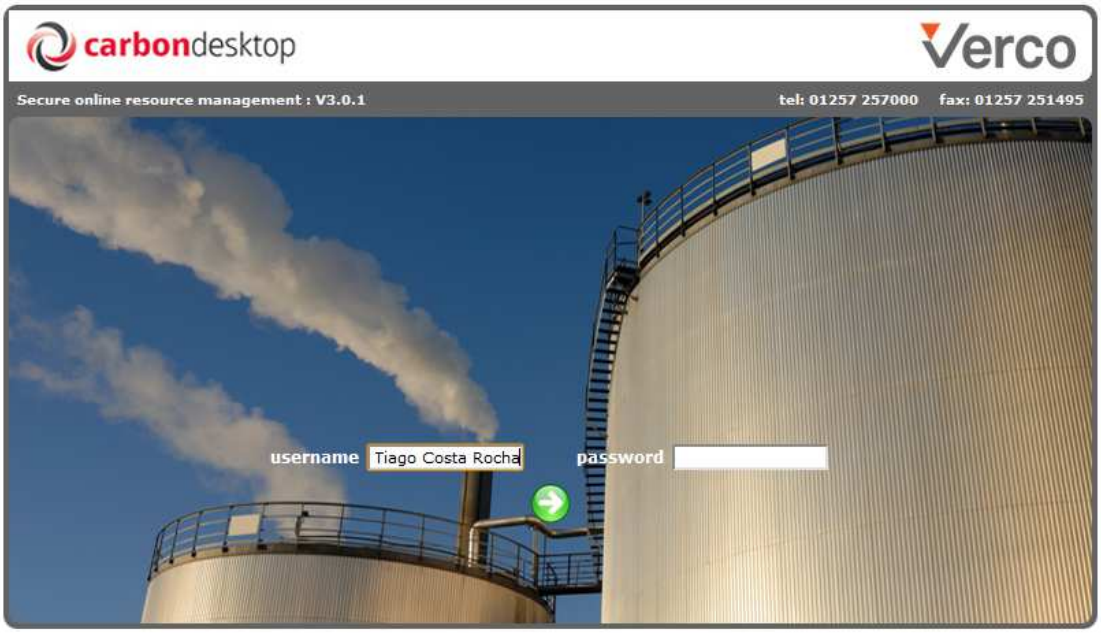


Figure 5.7 – Web based system opening interface

After logon, the interface with all the functionalities will appear, and the user can start working on the system.

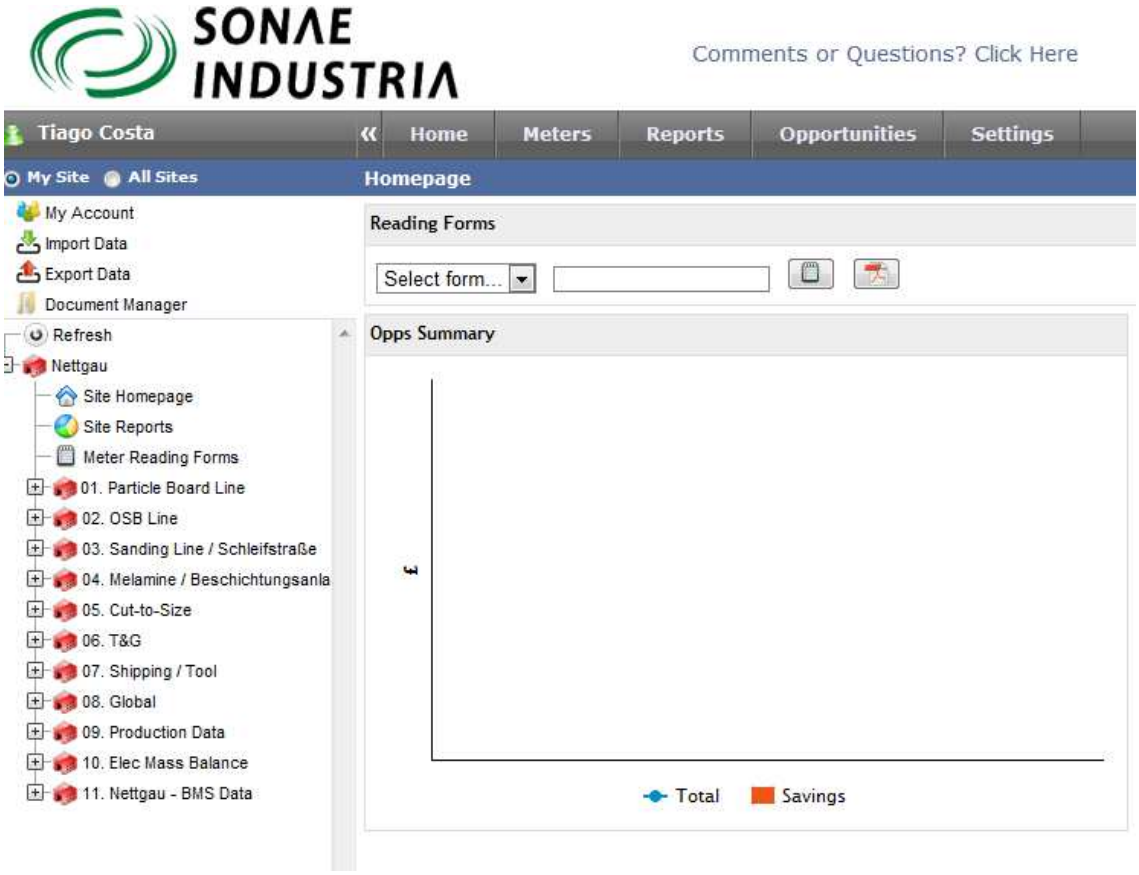


Figure 5.8 – User Main Interface

As it's possible to understand analyzing the picture, on the left side, the user can choose the different areas, inside each area, the meters relative to each consumer can be found.

Now, the focus will be on the particleboard chipper consumptions, values relative to a day interval will be placed, in an hourly base. I can be represented with data, like in the picture below, with time, consumption detailed and the cost associated to the consumption.

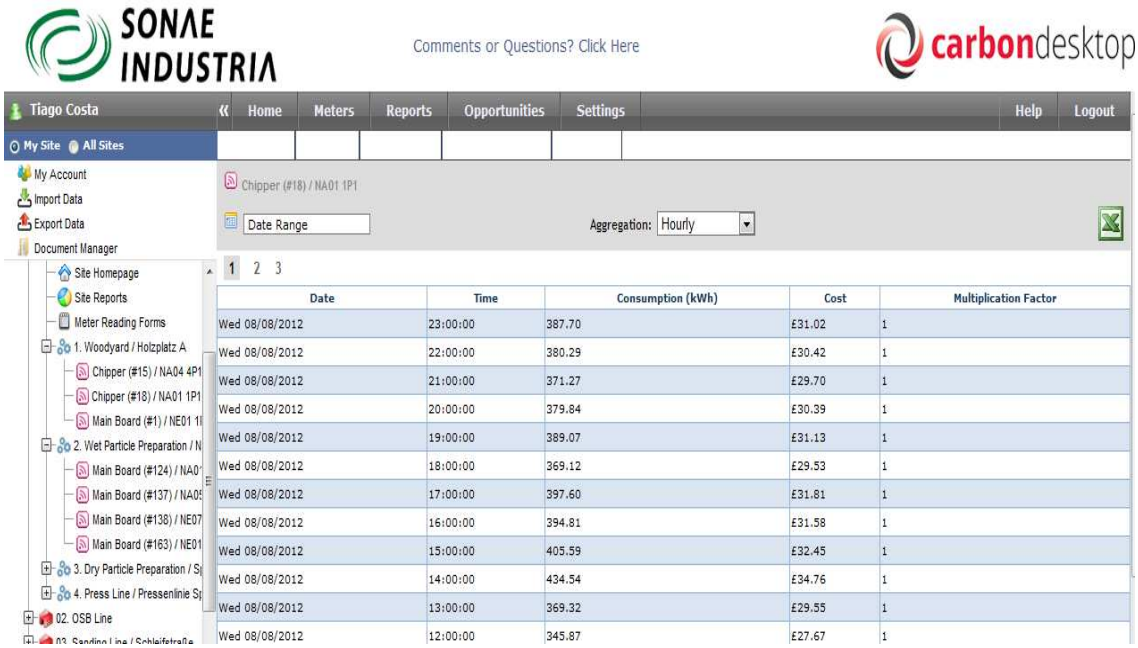


Figure 5.9 – Energy Consumptions Data

Or, it can be represented graphically, what will be important to include in the reports, as it's simpler and easier to give attention to an image than what it is with values as above. On the next picture, is represented the same machine consumption, for the same interval.

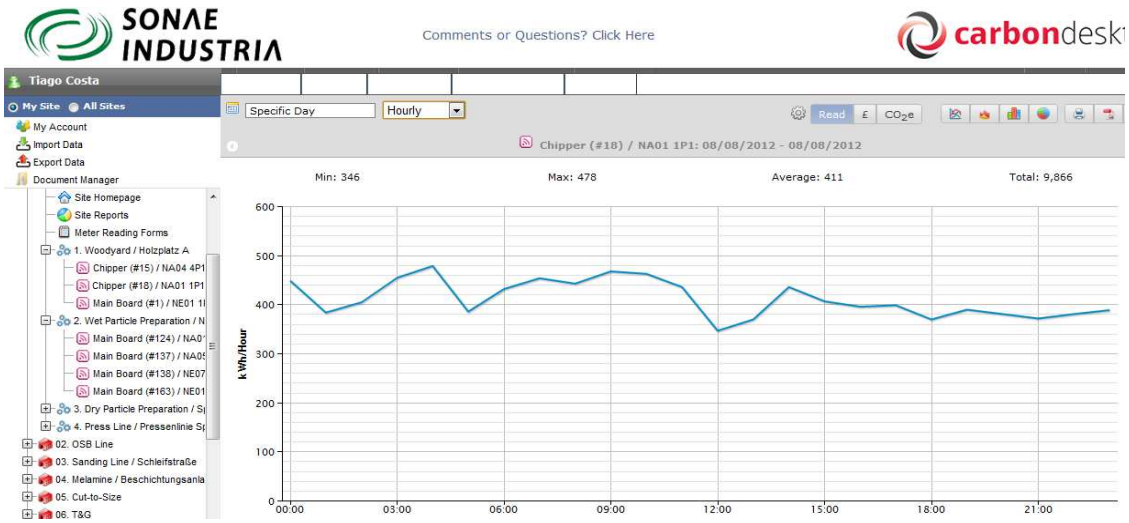


Figure 5.10 – Energy Consumptions Chart

This is the system, and fortunately it was working well at the end of the traineeship. A lot of work will be necessary in the future, off course the energy management within the group is being catalyzed with this system, but the most important part of the job comes after this process of installation and initialization.

Chapter 6

Conclusions and Recommendations

6.1 Recommendations and Future Work

The future work will be hard and complex. It will be maybe the most difficult part of this project. There are some tasks that need to be completed in the future and were already started during the traineeship. The main ones will be detailed on the next paragraphs.

BMS (Building Management System) – As it was said before, Nettgau plant is huge and modern, and as a huge number of meters, about 300. The wireless system only collects data from 60. Although, the factory had already a database placed in local software, collecting data from all the connected meters.

It was very important to raise the value from the new system, to realize an integration of this information on the EMS provider server. For that, a tool to program and synchronize both systems is needed, and plant team was already working on it.

Production Data – Specific energy consumptions are wanted as indicators for the energy team. In order to have organized data, the team needs to group all the information from almost a thousand production meters, in products, namely, PB, OSB and Melamine and inside each one of the products, different units are needed, like m, square meters and cubic meters. That's because, in different areas, different units makes sense, as example, let's imagine the sanding line. On the sanding line, where the boards are finished after the press,

it makes sense to have m^2, in order to get SEC in kWh/m^2. That part of the work was already being made and for sure it will be ready soon.

Reporting – The most important part, after all those phases completed, reports are needed. The time interval of the reporting needs to be defined, but if it how the team planned, it will be daily for the lines responsible, and monthly for the top management. The content of each kind of report will be different to the various destinations. It will vary of a visual report, with graphics, images and not much numbers, for the operators and their responsible, and a more completed one for the line managers, top management and corporation.

6.2 Conclusions

It was a pleasure to be part of such a big project. The objectives proposed for the traineeship, were all achieved, although there are lots of things to do yet, as the tool is powerful and all the functionalities should be explored.

Energy management, curiously was not a relevant theme on this plant, maybe because it's a new factory, and it seems to be effective, but, if the people inside start to look at this thematic with another view, they will save lots of money and for sure they will improve their own results, that are not bad already. Fortunately, after this almost 4 months, the people inside the factory, namely the team that worked on this project, are already looking at this tool, and taking some measures to start improving energetically.

SONAE Indústria Corporation, represented by Luis Ferraz, during my presence in Nettgau, shows an impressive work following each one of their sites around the globe, and supporting innumerous projects in a big range of different areas. It was really interesting and pleasant to be part of this multinational and help to promote the theme energy in one of their biggest plants.

The web based energy management system is working, now the team needs to work on it!

Appendix

Appendix A

Traineeship Plan

Action
Collection of all data required by VERCO
Identify type of meters.
Collect Energy distribution diagram
Obtain Meters Quantity (maker and model)
Meters communication protocol
Identify all diferent areas and sub-areas from our productive processes
Group meters per areas
Select a list of 60 meters considering the biggest factory consumers
VERCO Consultant Mathias Loser Audit on Site
General and Health&Safety Induction
Site Tour and Key Introductions
Check signal strength / frequency availability
Positioning of Repeators and Concentrator
Check meter pulses of some of the meters
System Software: A Guided Tour
Compile metering schedule and location of data concentrators and repeaters
Confirm IT requirements for data concentrator on site
Production Data and Reporting (PART I)
Global IT and VERCO interaction in order to clarify system specifications
Get examples of reporting from our EMS provider
Build first reports considering our experience and VERCO top-rated skills
Global IT Program development to build the file to interface the production data
Rui Dantas and Wilhem Mischer (both from Global IT) will be present on the session in Nettgau to participate on the customization of VERCO's tool and to receive training
Equipment Installation on Site
Prepare the meters in order to get pulse output, connecting optocouplers to each one of the 60 meters we have chosen
Check pulses from all meters
Receive equipment on site
Install Concentrator and Repeaters
Install 29 DC Transmitters and 2 SC Transmitters
Test Sinal Strengh from each trasmitter
Send Transmitter Serial Number, and respective associated meter to VERCO, and start monitoring immediately
Period to collect data and stabilise the system
Training & Commissioning Visit (PART I) (Partially Failed - Reschedule new Visit)
Set up Carbon Desktop
Set up Production Interface Program developed by Global IT

Rui Dantas and Wilhem Mischer (both from Global IT) will be present on the session in Nettgau to participate on the customization of VERCO's tool and to receive training
Handover the finalised system
Set up reports using Carbon Desktop
Overview of all meters results, in order to despite futures issues.
Solve concentrator connection problems.
Repair the repeators and place them once more, on the previously defined points.
Building Management System Integration
Liaise with KBR or global IT team to create automatic export of data from the KBR system to VERCO ftp
Verco should create importer to take KBR exported data and import into Carbon Desktop
Identify the meter in KBR that relates to the total gas incoming meter and inform Verco of the meter name for this within KBR.
Verco should setup a new meter in Carbon Desktop for the main gas consumption for Nettgau.
Production Data and Reporting (PART II)
Global IT should setup automatic export of production data on a daily basis into the Carbon Desktop FTP
Setup meters in Carbon Desktop to accept and display incoming production data from the SAP export
Discuss potential to produce monthly 'wood consumption' figures from SAP to export into Carbon Desktop
Carbon Desktop - Multilanguage Platform
Defined to be delivered within 2012 (as defined in VERCO proposal/contract). This capability is currently under development within VERCO software development team and a more accurate date for completion will be defined once this reaches the testing phase.
Provide local language support if VERCO requests for it.
Training & Commissioning Visit (PART II)
Set up Carbon Desktop
Rui Dantas and Wilhem Mischer (both from Global IT) will be present on the session in Nettgau to participate on the customization of VERCO's tool and to receive training
Handover the finalised system
attachments
Overview all of all meters results, in order to despite futures issues.

Table A.1 - Traineeship Tasks

Appendix B

Sixty Meter Selection for Transmitters placing

SONAE INDUSTRIA - GLUNZ AG - NETTGAU PLANT

Facility

PB **Area**

WOODYARD	Location	Meter Name	Address	Type
	SU1	NE01 1P1	1	Multimess
	SU1	NA04 4P1	15	Multimess
	SU1	NA01 1P1	18	Multimess

WET PARTICLES	**Location**	**Meter Name**	**Address**	**Type**
	SU2	**NA01 1P1**	**124**	**Multimess**
	SU2	**NA05 5P1**	**137**	**Multimess**
	SU2	**NE07 7P1**	**138**	**Multimess**
	SU2	**NE01 1P1**	**163**	**Multimess**

DRY PARTICLES	**Location**	**Meter Name**	**Address**	**Type**
	SU3	**NA01 1P1**	**201**	**Multimess**
	SU3	**NA05 5P1**	**209**	**Multimess**
	SU3	**NA07 7P1**	**210**	**Multimess**
	SU3	**NE08 8P1**	**226**	**Multimess**
	SU3	**NE06 6P1**	**227**	**Multimess**
	SU3	**NE01 1P1**	**243**	**Multimess**

PRESS LINE	**Location**	**Meter Name**	**Address**	**Type**
	SU4	**NE10 10P1**	**328**	**Multimess**
	SU4	**NE08 8P1**	**329**	**Multimess**
	SU4	**NE01 1P1**	**346**	**Multimess**

Facility

OSB Area

WOODYARD	Location	Meter Name	Address	Type
	OU2	NE01 1P1	101	Multimess
	OU2	NA04 4P1	120	Multimess
	OU2	NA01 1P1	123	Multimess

DRY PARTICLE	Location	Meter Name	Address	Type
	OU3	NE01 1P1	501	Multimess
	OU3	NE07 7P1	523	Multimess
	OU3	NA01 1P1	527	Multimess

PRESSLINE	Location	Meter Name	Address	Type
	OU4	NE01 1P1	301	Multimess
	OU4	NE08 8P1	317	Multimess

SL Area

SL	Location	Meter Name	Address	Type
	S4b	NE01 1P1	817	Multimess

Storage Place - Crane	Location	Meter Name	Address	Type
	SU5	NE07 7P2	430	Multicount

MELAMINE Area

MELAMINE 500 - KT1	Location	Meter Name	Address	Type
	SU5	NE12 12P2	439	Multicount

MELAMINE 501 - KT2	Location	Meter Name	Address	Type
	SU5	NE05 5P4	416	Multicount
	SU5	NE05 5P3	417	Multicount

MELAMINE-STORAGE	Location	Meter Name	Address	Type
	SU5	NE05 5P2	418	Multicount

ASPIRATION	Location	Meter Name	Address	Type
	SU5	NE02 2P6	402	Multicount

Facility

CUT-TO-SIZE Area

CUT-TO-SIZE 400	Location	Meter Name	Address	Type
CUT-TO-SIZE	SU5	NE03 3P3	411	Multicount
DESTACKING	SU5	NE03 3P2	412	Multicount

CUT-TO-SIZE 401	Location	Meter Name	Address	Type
CUT-TO-SIZE	SU5	NE03 3P6	408	Multicount
DESTACKING	SU5	NE03 3P5	409	Multicount

CUT-TO-SIZE 402	Location	Meter Name	Address	Type
CUT-TO-SIZE 2	OU5	NE03 3P1	609	Multicount
CUT-TO-SIZE 1	OU5	NE04 4P6	610	Multicount
LOADING	OU5	NE04 4P5	611	Multicount
DESTACKING	OU5	NE06 6P1	617	Multicount

ASPIRATION	Location	Meter Name	Address	Type
CUT-TO-SIZE 400 / 401	SU5	NE02 2P4	404	Multicount
CUT-TO-SIZE 402	SU5	NE02 2P5	403	Multicount

Facility

T & G Area

TONGUE & GROOVE	Location	Meter Name	Address	Type
CUT-TO-SIZE	OU5	NE03 3P5	605	Multicount
TONGUE & GROOVE	OU5	NE03 3P4	606	Multicount
ASPIRATION	SU5	NE02 2P3	405	Multicount
PACKING	O5	NE03 3P6	905	Multicount

Area

TOOL	Location	Meter Name	Address	Type
PACKING	OU5	NE03 3P2	608	Multicount
BATTERY POINT	OU5	NE04 4P4	613	Multicount
BATTERY POINT HALL	OU5	NE03 3P6	604	Multicount

Area

	Location	Meter Name	Address	Type
COMP. AIR SYSTEM 1	SU5	NE11 11P2	437	Multicount
COMP. AIR SYSTEM 2	SU5	NE06 6P1	425	Multicount
COMP. AIR SYSTEM 3	SU5	NE11 11P3	435	Multicount
COMP. AIR SYSTEM 4	SU5	NE06 6P2	424	Multicount
COMP. AIR SYSTEM 6	SU5	NE06 6P3	423	Multicount
COMP. AIR SYSTEM 7	SU5	NE07 7P3	429	Multicount
MAIN-METER (ELECT.)	OU5		601	Multimax

Appendix C

ISO 50001 – Main Concepts

ISO 50001 specifies requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and consumption.

ISO 50001 specifies requirements applicable to energy use and consumption, including measurement, documentation and reporting, design and procurement practices for equipment, systems, processes and personnel that contribute to energy performance.

ISO 50001 applies to all variables affecting energy performance that can be monitored and influenced by the organization. ISO 50001:2011 does not prescribe specific performance criteria with respect to energy.

ISO 50001 has been designed to be used independently, but it can be aligned or integrated with other management systems.

ISO 50001 is applicable to any organization wishing to ensure that it conforms to its stated energy policy and wishing to demonstrate this to others, such conformity being confirmed either by means of self-evaluation and self-declaration of conformity, or by certification of the energy management system by an external organization.

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